農業研究

第十七卷　第四期

目　次

水稻品種對栽植密度及氮素肥料之效應……………………張萬來…… 1
水稻品種對黃萎病抗病性之初步檢定試驗 ……………………………………………… 邱善美、林明華、黃真生……19
水稻宿根栽培方法之研究
（第三報）耕土深淺與不同施肥量對宿根稻之再生力及產量之差異 ……………………謝全份、高樹、江忠……24
水田殺草劑Knoxweed之治草效果……………………………張萬來……34
放射線誘發突變稻品系之糙米粗蛋白質含量 ……………………………………………陸培基、黃真生……41
不同覆蓋物與施肥量對檸檬草油分之影響 ………………… 楊永裕……47
罹病植物之組織隔離反應 ………………………………… 杜金池……51
大豆細菌性斑點病之研究 …………………………朱啓魯、陳建忠……57
洋菇腦菌病病原菌生理研究（第二報）…………杜自彊、于紫靜……65
溴化甲烷燻蒸對洋菇病害預防之效果 ……………………杜自彊……75
文獻介紹 ……………………………………………………………80

臺北市古亭區羅斯福路四段

臺灣省農業試驗所出版

中華民國五十七年十二月

RESPONSE OF RICE VARIETY TO PLANT SPACING AND NITROGEN FERTILIZATION[1]

W. L. Chang[2]

Growing rice with spacings of 22–25 cm between rows and 20–24 cm between hills (56–64 hills per 3.3 m^2) introduced by Iso (1930) and nitrogen application of about 80 kg per ha has been widely accepted as a standard cultural practice in Taiwan during the past three decades. Recently, however, attempt has been made to plant rice more closely and to apply more nitrogen fertilizer in order to obtain higher grain yields. Experimental findings so far obtained are generally encouraging (Chang and Yang, 1965) and the present trend of rice cultivation in Taiwan has been gradually moving toward dense planting and heavy fertilization. Currently, plant spacings of either 24 x 15 cm (90 hills per 3.3m^2) or 27 x 13.5 cm (89 hills per 3.3 m^2) and nitrogen application of about 100 kg per ha are generally recommended. The adoption of this improved cultural practice has already achieved a great yield increase in paddy yields as indicated by the results of so called "integrated demonstration" project initiated in the fall rice crop of 1963 in Taiwan (Huang, 1967).

It has been reported that responses of rice to spacing and nitrogen varied with varieties (Matsuo, 1952) and crop seasons (Tanaka *at al.*, 1964). However. information is still not available regarding the optimum levels of spacings and nitrogen necessary for a given variety to attain a maximum grain yield at a given crop season. An understanding of interactions among varieties, spacings, and nitrogen levels at different crop seasons may be useful to rice workers in their efforts to explore the possibility of further increasing unit yield of rice by dense planting and heavy fertilization. The odjective of this investigation was to determine the responses of two *japonica* rice varieties to four spacing treatments and three nitrogen levels in both the first and the second crops at Chianan area of Taiwan.

---

1. This experiment was supported by the Joint Commission on Rural Reconstruction (JCRR) under the projects of 65-All-A-1658, 66-All-A-1716, and 67-All-A-1822.

2. Agronomist, Chiayi Agricultural Experiment Station, TARI. The author wishes to express his sincere thanks to Professor C. H. Huang, Senior Specialist, JCRR, for his helpful advice during the course of this study. The author also wishes to thank Mr. L. Li, Agronomist, CAES, for his help in statistical analysis of the data.

MATERIALS AND METHODS

Six field experiments were conducted during the period from 1965 to 1967 at Tai–tou–ken Farm of the Chiayi Agricultural Experiment Station. The variables included four plant spacings, 3 nitrogen levels, and two rice varieties. Plant spacing were 30 x 20, 30 x 15, 30 x 10, and 30 x 5 cm which gave approximately 55, 73, 110, and 220 hills per $3.3m^2$, respectively. These spacings are named as "wide–row and close–hill" spacings because inter–row spacings are kept wide and increased planting densities are obtained through the reduction of intra–row spacings. The nitrogen levels were 80, 120, and 160 kg per ha applied in the form of ammonium sulphate. Calcium superphosphate and potassium sulphate were used as carriers of P_2O_5 and K_2O which were applied both at the rate of 100 kg per ha. Rice varieties used in this trial were Chianung 242, a *japonica* rice variety of panicle weight type, and Tainan 3, the best tillering *japonica* rice variety carrently available in Taiwan, which was selected to represent the panicle number type.

Tai–tou–ken soil is relatively low in fertility, and typical of the soil of this type on the rain–fed plains of Chinan district. The predominant soil type in the experimental area was silty clay loam. The surface soil contained 0.94% organic matter. The available P_2O_5 and K_2O were 145 and 90 kg per ha, respectively. The pH of the surface soil was 6.6.

The field experiment was laid out in a randomized block, split–plot design with four replications. Nitrogen levels made the whole plots whereas factorial combinations of plant spacings and rice varieties comprised the subplots. Subplot size was 1.5 x 6.0 m and consisted of 5 rows. An extra row was included at both sides of the main plots to eliminate border effects.

The whole plots were harvested for yield determination. Besides grain yield, data for components of yield and some traits of agronomic importance were also recorded. A combined analysis of variance was made for grain yield over 3 years in both crops. The orthogonal linear, quadratic, and cubic comparisons were calculated as described by Snedecor (1961). Leaf area at the heading stage was measured in both crops of 1966 and 1967 by the method of Bhan and Pande (1966). Plasticity index was calculated by the formula suggested by Tanaka (1967).

EXPERIMENTAL RESULTS

Effect of Plant Spacing on Grain Yield

The highest yields were obtained by the most close spacing of 30 x 5 cm (Table 1). When averaged over years, nitrogen levels, and varieties, grain yield increased 50, 205, and 338 kg per ha or 0.77, 3.17, and 5.22% in the first crop, and 92, 225, and 303 kg per ha or 1.72, 4.21, and 5.67% in the second one at the spacings of 30×15, 30×10, and 30x5 cm, respctively. The effect of plant spacing on grain yield was highly significant in both crops (Table 2). Variation in spacing effect was due principally to linear regression.

Table 1. Grain yield and density response of 2 rice varieties, 1965–1967.

Variety	Spacing (cm)	Grain yield (kg/ha)		Density response (increage in kg/ha)		Density response (% increase)	
		First crop	Second crop	First crop	Second crop	First crop	Second crop
Chianung 242	30×20	6,287	5,135	—	—	—	—
	30×15	6,189	5,173	−98	38	− 1.56	0.74
	30×10	6,463	5,276	176	141	2.80	2.74
	30× 5	6,611	5,380	324	245	5.15	4.77
Tainan 3	30×20	6,661	5,556	—	—	—	—
	30×15	6,860	5,704	199	148	2.99	2.66
	30×10	6,896	5,865	235	309	3.53	5.56
	30× 5	7,012	5,918	351	362	5.27	6.52
Average of 2 varieties	30×20	6,474	5,346	—	—	—	—
	30×15	6,524	5,438	50	92	0.77	1.72
	30×10	6,679	5,571	205	225	3.17	4.21
	30× 5	6,812	5,649	338	303	5.22	5.67

There was no significant variety x spacing interactions in both crops (Table 2). The grain yields of both varieties generally increased with the decrease in plant spacing. The degree of varietal response to spacing was essentially the same, since plasticity indices for both varieties at various spacings were quite similar in both crop seasons (Table 3). The year x spacing, and year x spacing x variety interactions were not significant. Apparently, varietal responses to spacing varied slightly with years in both crops.

Table 2. Analysis of yield variance for combined 1965–1967 data.

Source of variation	D.F.	First crop		Second crop		LSD	
		M. S.	F.	M. S.	F.	5%	1%
Year	2	36,910,935	106.64**	18,629,990	53.80**	3.55	6.01
Nitrogen levels	2	34,437,223	99.49**	5,440,183	15.71**	3.55	6.01
Linear	(1)	64,418,740	186.11**	10,753,660	31.06**	4.41	8.28
Quadratic	(1)	4,455,705	12.87**	126,706	0.37	4.41	8.28
Nitrogen levels x Years	4	6,534,327	18.88**	617,940	1.78	2.93	4.58
Error a	18	346,123		346,272			

Varieties	1	14,019,572	90.19**	13,120,003	134.39**	3.89	6.76
Spacings	3	1,543,565	9.93**	938,712	9.62**	2.65	3.88
Linear	(1)	4,438,780	28.56**	2,787,136	28.55**	3.89	6.76
Quadratic	(1)	135,278	0.87	8,022	0.08	3.89	6.76
Cubic	(1)	56,638	0.36	20,976	0.21	3.89	6.76
Varieties x Spacings	3	292,291	1.88	56,593	0.58	2.65	3.88
Years x Varieties	2	242,355	1.56	115,571	1.18	3.04	4.71
Years x Spacings	6	425,480	2.74*	49,369	0.51	2.14	2.90
Nitrogen levels x Varieties	2	1,142,718	7.35**	19,133	0.20	3.04	4.71
Nitrogen levels x Spacings	6	132,564	0.85	158,524	1.62	2.14	2.90
Years x Nitrogen levels x Varieties	4	240,291	1.55	18,699	0.19	2.41	3.41
Years x Nitrogen levels x Spacings	12	162,976	1.05	55,686	0.57	1.82	2.30
Years x Varieties x Spacings	6	76,675	0.49	55,131	0.56	2.14	2.90
Nitrogen levels x Varieties x Spacings	6	244,277	1.57	39,364	0.40	2.14	2.90
Years x Nitrogen levels x Varieties x Spacings	12	134,290	0.86	29,854	0.31	1.82	2.30
Error b	189	155,442		97,629			

*Sighificant at 5% level. **Significant at 1% level.

Table 3. The plasticity of rice varieties in response to spacing, 1965-1967.

Variety	Crop season	Grain yield per hill (g)				Plasticity index		
		30× 5cm (A)	30×10cm (B)	30×15cm (C)	30×20cm (D)	B/A	C/A	D/A
Chianung 242	First crop	9.9	19.4	27.9	37.6	1.96	2.82	3.80
	Second crop	8.1	15.8	23.3	30.7	1.95	2.88	3.79
Tainan 3	First crop	10.5	20.7	30.9	39.9	1.97	2.94	3.80
	Second crop	8.9	17.6	25.7	33.3	1.98	2.89	3.74
Average of 2 varieties	First crop	10.2	20.1	29.4	38.8	1.97	2.88	3.80
	Second crop	8.5	16.7	24.5	32.0	1.96	2.88	3.76

Effect of Nitrogen Level on Grain Yield

Grain yield of rice were maximized when rice plants were given 160 kg of nitrogen per ha (Table 4). The average grain yields increased 889 and 1,212 kg per ha or 15.01 and 20.47% in the first crop, and 335 and 543 kg per ha or 6.43 and 10.43% in the second one

at 120 and 160 kg of nitrogen per ha, respectively. The response of grain yield to the increase of nitrogen was more pronounced in the first crop season. Differences of grain yield among nitrogen levels were significant at the 1% level in both crops (Table 2). However, the nature of response differed with crop seasons. In the first crop, the regression of grain yield on nitrogen level was parabolic in form, the rate of yield increase reducing more rapidly with the increase of nitrogen. The regression was essentially linear in the second crop, the rate of yield increase at different levels of nitrogen being almost the same.

Table 4. Grain yield and nitrogen response of 2 rice varieties, 1965–1967.

Variety	Nitrogen level (kg/ha)	Grain yield (kg/ha)		Nitrogen response (increase in kg/ha)		Nitrogen response (% increase)	
		First crop	Second crop	First crop	Second crop	First crp	Second crop
Chianung 242	80	5,808	4,965	—	—	—	—
	120	6,463	5,273	655	308	11.28	6.20
	160	6,893	5,485	1,085	520	18.68	10.47
Tainan 3	80	6,038	5,452	—	—	—	—
	120	7,159	5,813	1,121	361	18.57	6.62
	160	7,375	6,019	1,337	567	22.14	10.40
Average of 2 varieties	80	5,922	5,208	—	—	—	—
	120	6,811	5,543	889	335	15.01	6.43
	160	7,134	5,751	1,212	543	20.47	10.43

The nitrogen x year interaction was significant only in the first crop. This interaction was resulted largely from the poor nitrogen response in the first crop of 1967. There was also a highly significant nitrogen x variety interaction in the first crop. The grain yield of Tainan 3 showed a curvilinear response to the increase of nitrogen, but the response of Chianung 242 was essentially linear (Table 5). The grain yields of both varieties responded similarly to nitrogen in the second crop, thus accounting for the lack of a nitrogen x variety interaction. Both varieties generally produced better grain yields at the higher level of nitrogen in both crops of the years tested, since there were no significant year x nitrogen x variety interactions.

Table 5. Linear, quadratic and cubic comparisons for each variety in combined 1965–1967 data.

Treatment	Variety	Comparison	D.F.	Firs tcrop		Second crop		LSD	
				M. S.	F.	M. S.	F.	5%	1%
Nitrogen levels	Chianung 242	Linear	1	25,745,120	74.38**	4,898,325	14.15**	4.41	8.28
		Quadratic	1	370,653	1.07	26,354	0.08	4.41	8.28

	Tainan 3	Linear	1	39,396,900	113.82**	5,877,630	16.97**	4.41	8.28
		Quadratic	1	5,647,208	16.32**	116,323	0.33	4.41	8.28
Spacings	Chianung 242	Linear	1	2,461,482	15.84**	966,314	9.90**	3.89	6.76
		Quadratic	1	528,202	3.40	20,760	0.21	3.89	6.76
		Cubic	1	398,509	2.56	2,387	0.02	3.89	6.76
	Tainan 3	Linear	1	1,989,827	12.80**	1,898,820	19.45**	3.89	6.76
		Quadratic	1	42,694	0.27	73,306	0.75	3.89	6.76
		Cubic	1	86,854	0.56	24,325	0.25	3.89	6.76

**significant at 1% level.

Effect of Plant Spacing and Nitrogn Level on Grain yield

Varietal responses to spacing at each nitrogen level are shown in Figure 1. The grain yields of both varieties were higher at closer spacing at each nitrogen level in both crops with the following exceptions: lower yields of 30 x 10 and 30 x 5 cm spacings of Tainan 3 in the first crop and all 3 closer spacings of Chianung 242 in the second crop at the highest nitrogen level. As a result, closer spacings showed only limited yield advantage at 160 kg of nitrogen per ha in the second crop, when data were pooled over varieties.

Rice varieties generally produced highest yields at the highest nitrogen level at each spacing except 160 kg per ha of nitrogen at 30 x 5 cm spacing of Chianung 242 in the second crop (Figure 2). Consequently, average yields of 120 and 160 kg of nitrogen per ha were almost similar at 30 x 5 cm spacing in the second crop. Because of largely independent effects of nitrogen and spacing, nitrogen x spacing interactions were not significant in both crops.

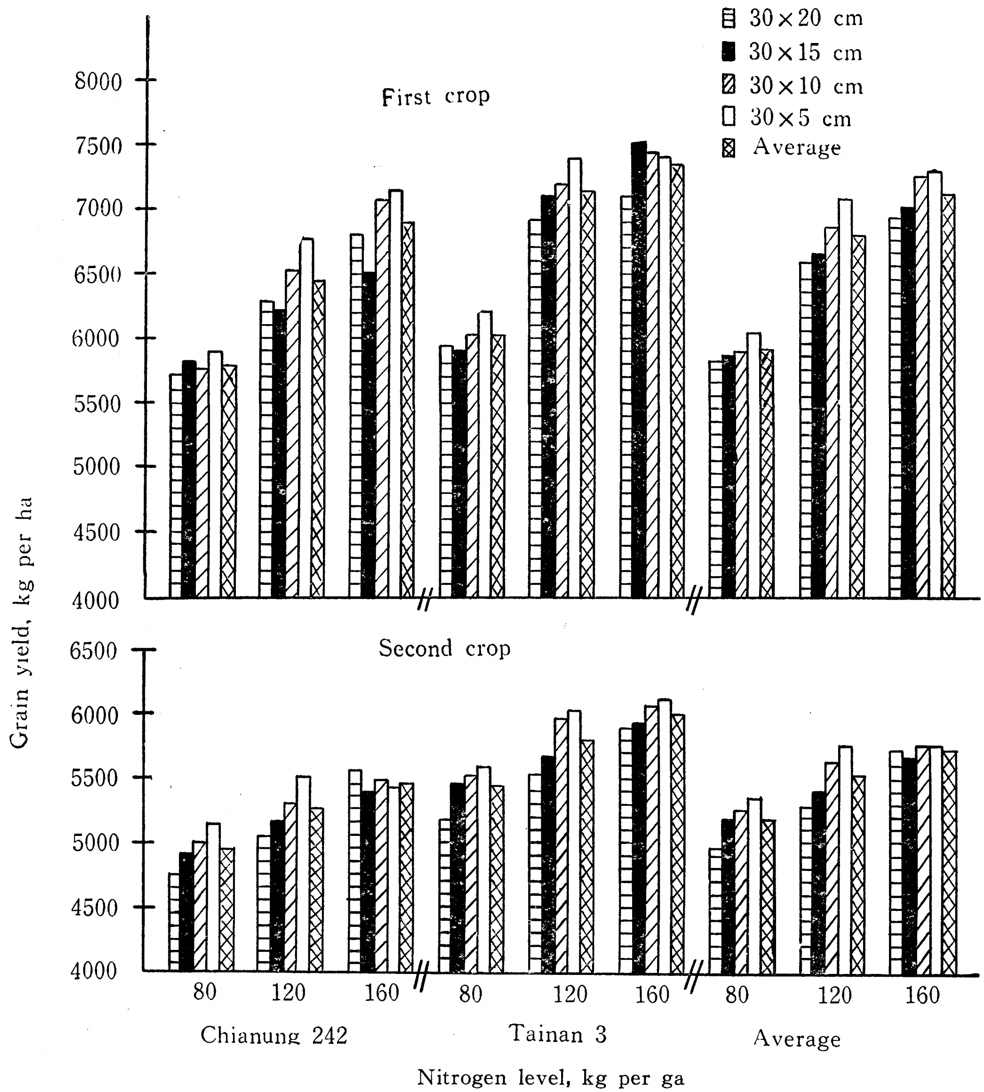


Figure 1. Yield response of 2 rice varieties to spacing at 3 levels of nitrogen, 1965-1967.

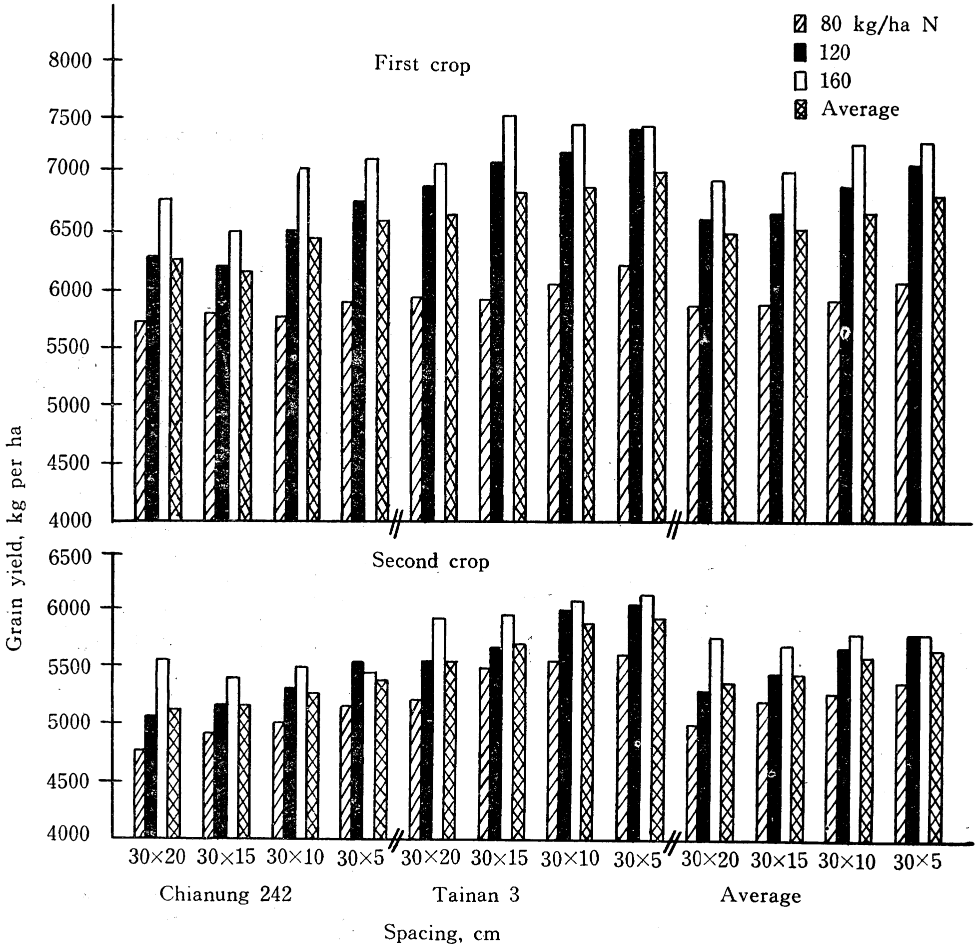


Figure 2. Yield response of 2 rice varieties to nitrogen level at 4 spacings, 1965-1967.

Multiple correlation coefficients (R) in Table 6 showed that nitrogen and spacing were possitively correlated with grain yield of rice. The correlations in the first crop were generally larger than those of the second one, although all correlations were significant at the 1% level. F values of multiple regression in the first crop were also considerably bigger than those of the second one. Coefficients of determination (R^2) showed that yield variations of about 40 and 21% in Chianung 242 and 43 and 17% in Tainan 3 could be ascribed to the joint effects of nitrogen and spacing in the first and the second crops, respectively.

Table 6. Multiple correlation coefficients, (R), coefficients of determination (R^2) and F values of multipliple regression of grain yield on nitrogen levels and spacings.

	Chianung 242		Tainan 3		Average of 2 varieties	
	First crop	Second crop	First crop	Second crop	First crop	Second crop
Multiple correlation coefficients (R)	0.6292**	0.4588**	0.6599**	0.4149**	0.6171**	0.3916**
Coefficients of determination (R^2)	0.3959	0.2105	0.4355	0.1721	0.3808	0.1534
F values of multiple regression	30.58**	12.44**	36.00**	9.70**	58.21**	17.15**

**significant at 1% level.

There were no significant year x nitrogen x spacing, variety x nitrogen x spacing, and year x variety x nitrogen x spacing interactions in both crops. Both varieties generally gave highest yields at close spacing and at the high nitrogen level during the years of the experiment.

Effect of Plant Spacing and Nitrogen Level on Componont s of Yield

Number of panicles per hill, number of grains per panicle, weight of 1,000 grains, and percentage of fertility of both varieties as influenced by spacing and nitrogen treatments are summarized in Table 7. The number of panicles per hill of both rice varieties increased with the increase of nitrogen but decreased quite drastically with the decrease of spacing in both crops. The number of grains per panicle also decreased with the decrease of spacing. However, the effect of nitrogen on the number of grains per panicle was rather irregular. In the first crop, it decreased slightly when nitrogen was raised from 80 to 120 kg per ha, but increased slightly when nitrogen was raised from 120 to 160 kg per ha. The response was similar in both varieties. In the second crop, the number of grains per panicle of Chianung 242 increased and that of Tainan 3 decreased with the increase of nitrogen. The changes, however, were rather small. Added nitrogen generally decreased 1,000-grain weight in the first crop, but increased it in the second one. The weight of 1,000 grains showed a slight increase with the decrease of spacing in both crops. The fertility percentage of both varieties also decreased with the increase of nitrogen and increased with the decrease of spacing in both crops.

Table 7. Mean values of yield components of 2 rice varieties grown at 4 spacings and 3 levels of nitrogen, 1965-1967.

Treatment	Number of panicles per hill		Number of panicles per 3.3m		Number of grains per panicle		Weight of 1,000 grains (g)		Fertility (%)	
	First crop	Second crop	First crop	Second crop	First crop	Second crop	First crop	Second crop	First crop	Second crop
Chianung 242										
Nitrogen										
80 kg/ha	9.4	7.2	882.5	676.4	131.0	145.8	29.6	29.2	97.3	92.2
120 kg/ha	10.4	7.5	978.8	722.7	126.4	148.6	29.3	29.4	93.4	91.2
160 kg/ha	11.4	8.5	1,068.0	803.8	128.8	149.6	28.9	29.6	92.8	90.6
Spacing										
30x20 cm	14.8	10.9	810.5	595.8	138.4	157.6	29.1	29.3	92.8	90.7
30x15 cm	12.3	9.0	894.1	656.4	131.6	149.5	29.1	29.5	92.9	90.9
30x10 cm	8.9	6.6	977.8	721.4	129.1	149.9	29.3	29.4	93.4	91.3
30x 5 cm	5.6	4.4	1,223.5	963.5	117.0	135.0	29.5	30.0	94.0	92.6
Tainan 3										
Nitrogen										
80 kg/ha	11.8	8.7	1,109.0	829.0	116.5	138.0	27.6	27.8	95.4	92.2
120 kg/ha	13.4	9.5	1,261.0	875.1	115.8	138.3	27.3	28.0	94.8	90.8
160 kg/ha	14.7	10.2	1,371.8	950.3	119.7	136.6	27.1	28.2	93.9	91.6
Spacing										
30x20 cm	19.2	13.3	1,053.9	708.8	123.7	146.3	27.2	27.8	94.3	92.2
30x15 cm	15.7	11.2	1,148.1	803.3	121.3	141.4	27.3	28.0	94.5	90.2
30x10 cm	11.1	8.2	1,215.8	895.3	117.7	133.9	27.4	28.1	94.7	91.7
30x 5 cm	7.2	5.1	1,571.2	1,131.8	107.7	129.0	27.7	28.1	95.2	92.1

Effect of Plant Spacing and Nitrogen Level on Leaf Area Index

The leaf area index (LAI) of Tainan 3 at the heading stage was larger than that of Chianung 242 in both crop seasons (Table 8). The LAI increased with the increase of nitrogen application and with a reduction in spacing. However, the degree of increase in LAI by nitrogen was considerably greater than that of spacing. The LAI in the first crop was also larger than that in the second crop. When averaged over varieties, LAI at the heading was generally correlated positively with grain yield of rice. The correlations in the first crop were not significant except that of 30 x 5 spacing which was significant at 5% level (Table 9). In the second crop, however, correlations were all significant at the 1% level except

those of 120 and 160 kg of nitrogen per ha which were significant at the 5% level. In the first crop, the correlation coefficients became smaller with the increase of nitrogen but were rather irregular in the spacing treatments. The degree of association between LAI and grain yield gegerally decreased with the increase of nitrogen and the reduction in spacing.

Table 8. Leaf area index (LAI) of 2 rice varieties grown at 4 spacings and 3 rates of nitrogen, 1966–1967.

	First crop			Second crop		
	Chianung 242	Tainan 3	Average of 2 varieties	Chianung 242	Tainan 3	Average of 2 varieties
Nitrogen						
80 kg/ha	4.64	5.08	4.86	3.38	3.87	3.36
120 kg/ha	5.05	6.19	5.62	4.03	4.64	4.34
160 kg/ha	5.95	7.44	6.70	4.48	5.21	4.85
Spacing						
30x20 cm	4.74	5.74	5.24	3.38	4.24	3.81
30x15 cm	5.24	6.24	5.74	3.72	4.41	4.07
30x10 cm	5.21	6.04	5.63	4.06	4.52	4.29
30x 5 cm	5.65	6.94	6.30	4.69	5.12	4.91

Table 9. Correlation coefficients between leaf area index and grain yield of rice 1965–1967.

	Nitrogen level (kg/ha)			Spacing (cm)			
	80	120	160	30x20	30x15	30x10	30x 5
First crop	0.1781	0.1293	– 0.0500	0.3627	0.0898	0.3540	0.4462*
Second crop	0.5080**	0.4462*	0.4136*	0.7398**	0.6044**	0.5980**	0.5154**

*significant at 5% level. The d.f. was 30 for nitrogen and 22 for spacing.

**significant at 1% level.

Effect of Plant Spacing and Nitrogen Level on Some Agronomic Traits

The effects of spacing and nitrogen on some agronomic characters of rice varieties Chianung 242 and Tainan 3 are presented in Table 10. Heading date tended to be delayed by the increase of nitrogen, but hastened by the reduction of spacing. Added nitrogen increased

plant height whereas reduced spacing decreased it. Panicle length was slightly increased by nitrogen and decreased by spacing. Panicle weight was not affected by the increase of nitrogen but decreased slightly with the reduction in spacing. High nitrogen level and close spacing generally resulted in the small grain-straw ratio. Both varieties responded similarly to spacing and nitrogen treatments in both crops.

Table 10. Mean values of some agromic traits of 2 rice varieties grown at 4 spacings and 3 levels of nitrogen, 1965-1967.

	Heading date		Plant beight		Panicle length		Panicle weight		Grain/straw	
	First crop	Second crop	First crop	Second crop	First crop	Second crop	First crop	Second crop	First crop	Second crop
Chianung 242										
Nitrogen										
80 kg/ha	103.8	72.8	105.7	115.9	23.3	23.5	3.8	4.4	1.83	1.56
120 kg/ha	103.7	72.7	110.3	119.9	23.1	24.0	3.6	4.1	1.74	1.56
160 kg/ha	105.1	72.5	114.8	123.4	22.9	24.4	3.6	4.1	1.68	1.43
Spacing										
30x20 cm	104.7	72.7	113.5	121.8	23.6	24.1	3.9	3.9	1.85	1.56
30x15 cm	104.4	72.7	112.8	121.4	23.2	23.9	3.6	3.8	1.69	1.55
30x10 cm	103.9	72.7	109.3	119.9	23.1	24.0	3.6	3.7	1.74	1.50
30x 5 cm	103.8	72.7	105.4	115.8	22.9	23.9	3.4	3.8	1.72	1.44
Tainan 3										
Nitrogen										
80 kg/ha	102.9	71.8	96.1	107.0	21.5	22.1	3.2	3.5	1.90	1.56
120 kg/ha	103.6	72.1	102.5	110.6	21.5	22.5	3.1	3.5	1.75	1.53
160 kg/ha	103.8	72.3	107.1	115.7	21.6	22.7	3.2	3.5	1.61	1.51
Spacing										
30x20 cm	103.3	72.4	104.5	112.9	21.8	22.7	3.3	3.8	1.87	1.57
30x15 cm	103.7	72.4	103.0	112.2	21.8	22.5	3.3	3.6	1.71	1.54
30x10 cm	103.3	71.9	100.9	110.7	21.4	22.3	3.1	3.4	1.62	1.51
30x 5 cm	103.5	71.5	98.4	108.7	21.0	22.1	2.9	3.3	1.66	1.38

DISCUSSION

The data generally indicated a yield advantage of close spacing and high nitrogen application. This is of great significance to rice production in Taiwan in view of the present

trend of rice cultivation in trying to obtain high yield through close spacing and heavy fertilization. Spacing and nitrogen are generally regarded as two important factors determing grain yield of rice (Matso, 1965). However, the effect of spacing was considerably smaller than that of nitrogen. It was observed that doubling the amount of nitrogen gained more than 20 and 10% yield increases in the first and the second crops respectively, whereas a four-fold reduction in spacing resulted in only a 5 % increase in grain yield in both crop seasons. The low density response of rice may be due to the following two factors: (1) Rice plants produced more panicles per hill at at wide spacing which partially compensated for decreased stand density at wide spacing. (2) The widest spacing of this experiment, 30 x 20 cm may be considered as a close spacing when compared with the existing planting density of 56–64 hills per 3.3 m^2 in Taiwan or an ordinary spacing, 30 x 30 cm, commonly adopted in the Southeast Asia (Kawano and Tanaka, 1968). Density response within close spacings is naturally limited in magnitude. Under the present circumstances, increase in nitrogen rather than reduction in spacing should be emphasized.

It is of interest to note that the grain yield of Chianung 242 responded linearly whereas that of Tainan 3, curvilinearly to the increase of nitrogen in the first crop, indicating that Chianung 242 has greater potentiality for yield increase at higher nitrogen level than Tainan 3. It was found that total nitrogen responses of Tainan 3 at nitrogen levels of 120 and 160 kg per ha were larger than those of Chianung 242. However, the net nitrogen response from medium to high nitrogen levels of Tainan 3 (3.57%) was less than half that of Chianung 242 (7.40%), showing that nitrogen level for maximum yield production is probably not far from 160 kg per ha with Tainan 3; with Chianung 242, however, continueous yield increase is highly likely even nitrogen exceeds substantially the level of 160 kg per ha. Chang (1967a) reported that Chanung 242 is more adaptable to higher level of fertility because it was developed under such environmental condition. Tanaka *et al.* (1964) also pointed out that some panicle weight type varieties respond well to heavy nitrogen because panicle number types suffer from mutual shading more seriously. With limited nitrogen application, however, panicle number types respond to nitrogen better than panicle weight types as reported by Baba (1961).

There were no significant varietal differences in density response in both crops. The plasticity indices of both varieties at various spacings were quite similar indicating that the capacity of Chianung 242 and Tainan 3 in response to spacing may be the same. Chang (1967b) has pointed out that present commercial Ponlai variaties of Taiwan are generally of typical panicle weight types in comparison with Japanese varieties which are mostly of panicle number types. Although Tainan 3 tillers slightly better than Chianung 242, the difference is apparently too small in magnitude to cause any significant change in varietal response to spacing. Takahashi (1944) reported that panicle weight types showed better density response than panicle number types. Tanaka (1965) suggested that a high yield will probably be obtained with a weak tillaring variety closely spaced. Yamameto and Toriyama (1968) also suggested that a heavy panicle type is considered to be a desirable plant type in the high planting density.

It was observed that the response of grain yield to the increase of nitrogen in the first

crop was nearly twice as high as that in the second crop. The result was similar to that of the previous report (Chang and Yang, 1965). Results of Tanaka *et al.* (1964) also indicated a greater nitrogen response in the dry than in the wet seasons. Seasonal difference in density response was, however, very slight. The coefficients of determination indicate that spacing and nitrogen could account for no more than 20% of the variation in grain yield in the second crop which may be largely responsible for the low yielding ability of the second crop in Taiwan. The average temperature during 1965-'67 was 23.6°C in the first crop and 27.1°C in the second one, whereas the mean sunshine hours during ripening were 3.7 and 3.9 hours per day in the first and the second crops, respectively. It appears, therefore, that the greater nitrogen response in the first crop may be attributable to the lower temperature of the first crop, and sunlight is probably not a major factor causing low nitrogen response in the second crop.

In the tropics, rice plants tiller actively in rainy season because of higher temperature. Since the tillers per unit area is the major component of leaf area index (Tanaka *et al.*, 1964), the increase in foliage produces serious mutual shading and adversely affects grain yield. The reduction of grain yield casued by mutual shading is greater with larger application of nitrogen or if solar radiation is smaller (Tanaka et al., 1966) As solar radiation is usually less during the rainy season in the tropics, the effects of close spacing and heavy nitrogen application are seriously affected. The situation in Taiwan is, however, quite different from that prevailing in the tropics. In the second crop, an equivalent of rainy season in the tropics, rice plants produce less tillers, resulting in smaller leaf area index. Since there is usually no shortage of light during ripening of the second crop, mutual shading is not a serions problem. This was fully confirmed by the highly significant correlations between leaf area index and grain yield in the second crop. Thus, poor performance of close spacing and heavy nitrogen application in the second crop arises primarily from insufficient growth of rice plants. The importance of plant type on the varietal response to spacing and nitrogen also can not be neglected (Jennings and Beachell, 1965; Matsuo, 1965; Yamamoto and Toriyama, 1968)

The analysis of yield component revealed that the increase in the number of panicles per unit area was the major factor contributing to the yield increase at close spacing and heavy application of nitrogen. The result well agreed with those of Chang and Yang (1964) and Hsieh *et al.* (1966), The number of panicles per 3.3 m² of Tainan 3 was considerably higher than that of Chianung 242 which may be the main source of varietal difference in yielding ability at each treatment. Rice plants were taller in the second crop especially in the close spacing with heavy nitrogen application, suggesting that lodging is a problem in the second crop because plant height is negatively correlated with lodging resistance factor (Chang, 1967). Thus, lower yields of close spacings at highest nitrogen level of 160 kg per ha may be largely attributable to lodging. As lodging affects grain yield markedly (Jennings and Sornchai, 1964), every possible effort should be exerted to reduce its damage when rice is grown at close spacing with heavy nitrogen. Dense planting with "wide-row and close-hill spacing" offers an effective solution to this problem since wide-row spacing is likely to increase the absorption of incoming solar radiation, resulting in thicker and stronger culms to reduce lodging. Hsieh *et al.* (1966) also reported that the rectangular form of planting is

better in the second crop.

Based on the result of this experiment, the optimum levels of spacing and nitrogen for maximum yield production apper to be 30 x 5 cm spacing with 160 kg per ha of nitrogen and 30 x 5 cm spacing with 120 kg per ha of nitrogen for Chianung 242 or varieties of the similar plant type in the first and the second crops, respectively. For Tainan 3 or varieties like it, 30 x 15 cm spacing with 160 kg per ha of nitrogen in the first crop, and 30 x 5 cm spacing with 160 kg per ha of nitrogen in the second one may be the best combinations. From the average performance of these two varieties, a general conclusion seems to be that when the present commercial Ponlai varieties are used, 30 x 10 cm spacing with nitrogen application of 160 kg per ha and 30 x 5 cm spacing with 120 kg per ha of nitrogen are likely to yield best in the frist and the second crops,respectively. The difficulty of transplanting at close spacing can be easily solved when the transplanting machine or direct seeding method are successfully released for general use. The spacing and nitrogen responses can also be improved when new rice varieties with more desirable plant type become available. By a more efficient combination of cultural techniques and rice varieties, it is highly likely that rice production with close spacing and heavy application of nitrogen can be greatly stabilized in the near future.

SUMMARY

The responses of two *japonica* rice varieties, Chianung 242 and Tainan 3, to four spacings and three levels of nitrogen were studied over a 3-year period from 1965 to 1967 at Tai-tou-ken Farm of the Chiayi Agricultural Experiment Station.

Grain yields increased with the reduction of spacing and the increase of nitrogen which was more pronounced in the first crop of rice. The effects of plant spacings and nitrogen levels on grain yields were all significant at the 1% level of probability in both crops. Chianung 242 responded linearly and Tainan 3, curvilinearly to nitrogen in the first crop whereas in the second crop, both varieties showed linear response to nitrogen. The regression of grain yield to spacing was essentially linear in both crops and both varieties responded similarly. Coefficients of determination showed that about 40 and 20% of grain yield variations could be ascribed to the effects of spacing and nitrogen in the first and the second crops, respectively.

The number of panicles per hill and the number of grains per panicle decreased whereas the weight of 1,000 grains and the percentage of fertility increased with the reduction of spacing in both crops. The response was similar in both varieties. The number of panicles per hill increased and the percentage of fertility decreased with the increase of nitrogen. No differences in varietal response were observed in both crop seasons. The number of grains per panicle of Chianung 242 increased in the first crop and decreased in the second one with the increase of nitrogen, but Tainan 3 responded just in the opposite way. The weight of 1,000 grains of both varieties increased in the first crop and decreased in the second one with the increase of nitrogen. The number of panicles per unit area of both varieties increased with the reduction of spacing and increased with the increase of nitrogen.

Leaf area index of both varieties generally increased with the decrease of spacing and with the increase of nitrogen. Rice plants generally showed larger leaf area index in the first crop. Leaf area index was, however, more closely associated with grain yield in the second

crop.

Heading date was delayed by the increase of nitrogen but was hastened by the decrease of spacing. plant panicle weight was not affected by nitrogen but decreased slightly with the reduction of spacing. Grain-straw ratio decreased with the increase of nitrogen and the reduction of spacing. Both varieties responded similarly in both crops.

LITERATURE CITED

1. Baba, I. 1961. Mechanism of response to heavy manuring in rice varieties. IRC Newsletter 10(4): 9-16.
2. Bhan, V. M. and Pande, H, K. 1966. Measurement of leaf area of rice. Agron. J. 58 (4): 454.
3. Chang, T. T. 1967. Studies on lodging resistance. Ann. Rep. Int'l Rice Res. Inst. (1966) 79-81.
4. Chang, W. L. and S. C. Yang. 1964. E. ffects of split application of fertilizer and planting density in yield, component of yield, and other agronomic characters of rice. Jour. Taiwan Agr. Res 13(1): 16-27.
5. Chang, W. L. and S. C. Yang. 1965 Effect of growing conditions on yield and components of yield in rice. Jour. Taiwan. Agr. Res. 14 (2): 23-31.
6. Chang, W. L. 1967a. Influence of growing condition on the efficiency of selection in hybrid populations of rice, Taiwan Agr. Quart. 3(1): 81-101.
7. Chang, W. L. 1967b. Performance of Ponlai varieties in Japan. Kenshu report, Hiratsuka Japan. 10 pp.
8. Hsieh, C. F., S. Kao, and C. Chiang. 1966. Effects of different planting densities, amounts of fertilizer application and planting forms on the yield of rice. Jour. Taiwan Agr. Res. 15(4):7-22.
9. Huang, C. H. 1966. Integrated demonstration on improved rice cultivation in Taiwan (Republic of China) IRC Newsletter 15(4): 17-23.
10. Iso, E. 1930. Studies on the correlations between grain yield and other characters of rice and its application. Report No. 79. Agr. Div., Cent. Res. Inst. Taiwan.
11. Jennings, P. R. and S. Sornchai. 1964. The influence of lodging on rice yields. IRC Newsletter 13(3): 10-21.
12. Jennings, P. R. and H. M. Beachell. 1965. Breeding rice for nitrogen responsiveness. Symposium on the Mineral Nutrition of the Rice Plant pp. 449-457. IRRI.
13. Kawano, K. and A. Tanaka. 1968. Growth duration in relation to yield and nitrogen respons in the rice plant. Jap. J. Breeding. 18(1): 46-52.
14. Matsuo, J. 1952. Genecological studies on cultivated rice. Bull. Natl. Inst. Agr. Sci. Japan. Ser. D. 3:1-111.
15. Matsuo, T. 1965. Varietal responses to nitrogen and spacing. Sympossium on the Mineral Nutrition of the Rice Plant. pp. 437-448.
16. Snedecor, G. W. 1961. *Statistical Methods.* Iowa State Univ. Press. Ames, Iowa. 534 pp.

17. Takahashi, H. 1944. Rice cultivation in the Hokuriku district of Japan as seen from the standpoint of plant types of varieties. Agr. and Hort. 19(1): 129–135.

18. Tankaka, A., S. A. Navasero, C. V. Garcia, F. T. Parao, and E. Ramirez. 1964. Growth habit of the rice plant in the tropics and its effect on nitrogen response. IRRI Tech. Bull. 3: 1–80.

19. Tanaka, A. 1965. The nature of mutual shading. Ann. Rep. Int'l Rice Res. Inst. (1964), 57–63.

20. Tanaka, A., K. Kawano, and J. Yamaguchi, 1966. Photosynthesis, respiration, and plant type of the tropical rice plant. IRRI Tech. Bull 7: 1–46.

21. Tanaka, A. 1967. Grain yield, plasticity, and nitrogen response. Ann. Rep. Int'l Res. Inst. (1966) 16–17.

22. Yamamoto, T. and K. Toriyama. 1968. Effect of planting density on relation between yield and some agronomic traits in direct seeded rice plant. Jap. J. Breeding. 18(1): 27–32.

水稻品種對栽植密度及氮素肥料之效應

張　萬　來

中文摘要

本文係報告嘉義農業試驗分所自民國54年第1期作起至56年第2期作承辦全省性水稻寬行密植試驗之綜合報告。

栽植密度及氮素肥料之提高均能導致稻谷之增產，其效果在第1、2期作均極爲顯著，水稻品種在第1、2期作對栽植密度均顯示直線效應，惟對肥料效應則因品種及期作而異。在第1期作，嘉農242號顯示直線效應而臺南3號則爲曲線效應，在第2期作，兩品種之肥料效應均爲直線關係。由決定係數可知栽植密度及氮素肥料分別在第1、2期作決定大約40及20%之產量變異。

每株穗數及每穗粒數因密植而低減而千粒重及稔實率則因密植而增加。兩品種在第1、2期作之反應均同，水稻品種之每株穗數與稔實率在第1、2期作均因氮素之增施而增加，嘉農242號之每穗粒數在第1期作因增加氮素肥料而增加，第2期作則因氮素肥料之增加而減少，臺南3號之反應則與嘉農242號恰恰相反。兩品種之千粒重在第1期作則因增肥而增加，但在第2期作則因增肥而減低，每坪穗數均因增肥密植而增多。

葉面積指數大致隨增肥密植而加大，水稻之葉面積指數在第1期作較大，但其與稻谷產量之關係則以第2期作者爲密切。

生育日數因增肥而延長，而因密植而縮短，穗長受肥料影響較微，惟因密植而稍減，谷草比亦因增肥密植而低減。水稻品種在第1、2期作之反應大致相同。

水稻品種對黃萎病抗病性之初步檢定試驗

邱善美　林明華　黃真生

一、緒　言

水稻的黃萎病（Yellow dwarf）係由黑尾浮塵子（*Nephotettix apicalis*）及僞黑尾浮塵子（*N. cincticeps*）所傳播的一種菌質病（Mycoplasm disease）。本病普遍發生於亞洲國家，1910年在日本首先發現，而在臺灣則於1929年黑澤英一氏發現該病發生於第二期作之蓬萊稻。然在當時併不嚴重，殆至近年來發生率普遍增高。據農林廳之調查（如表一）於53年全省發病之水稻田面積爲 5,877.84公頃，發生地區以宜蘭縣、桃園縣、新竹縣、苗栗縣、臺中縣、彰化縣等爲主，其他縣市發生面積較少或無發生，但至54年全省發病面積增爲8,050.45公頃，55年復增爲 41,799.79公頃，此趨勢有繼續之傾向而成爲一嚴重水稻病害。

按本病之發生預防方法，雖可用藥劑驅除媒介昆蟲或淸除其潛伏處所，撲滅越冬成蟲或幼蟲，但媒介昆蟲移動性甚大，不易收事半功倍之效，故最經濟而有效的預防方法爲育成抗病品種。邱人璋氏（1966）綜合報告有關本省水稻品種之抗黃萎病檢定經過如下：1932年黑澤氏曾調查49個水稻品種之黃萎病抵抗性，其中包括臺中65號，發現全部品種均屬感病性。大崎氏（1948）檢定18個品種之本病抗病性，其中新竹 8 號、臺中153號、嘉南13號及高雄18號等四種未罹病。臺中改良場於 1960 年第二期作在東勢所做之稻熱病檢定田內意外的得到叄試品種之黃萎病反應。結果叄試45個品種全部罹病。南改育27號之罹病率最低，即11.9%。

爲對本病獲得進一步之認識，乃於民國57年第一期作進行試驗準備，同時進行檢定工作，玆將檢定方法及結果，作一簡要報導。

表一、水稻黃萎病發生之趨勢（單位：公頃）

年別／種類／區域	53年		54年		55年		56年		合計	
	黃萎病	黃葉病	黃萎病	黃葉病	黃萎病	黃葉病	黃萎病	黃葉病	黃萎病	黃葉病
臺北縣	92.00	—	—	—	905.90	—	603.70	—	1,601.60	—
宜蘭縣	1,095.64	—	2,346.90	1,503.50	4,190.08	187.00	4,426.60	—	12,059.22	1,690.50
臺北市	22.60	—	—	—	10.00	—	72.00	—	104.60	—
基隆市	—	—	2.30	—	1.20	—	0.80	—	4.30	—
陽明山	3.00	—	28.00	—	6.00	—	325.00	—	362.00	—
桃園縣	703.50	—	3,573.00	—	32,732.00	—	55.00	—	37,063.50	—
新竹縣	153.00	—	138.00	—	927.00	—	9,233.00	—	10,451.00	—
苗栗縣	1,204.00	—	165.70	—	475.51	—	955.00	—	2,800.21	—
臺中縣	2,116.55	—	434.70	69.00	440.30	216.00	15,730.50	57.50	18,722.05	342.50
彰化縣	287.20	—	1.35	788.60	—	—	169.40	6.20	457.95	794.80
南投縣	93.50	—	1,300.00	491.00	1,764.50	—	11,969.00	315.50	15,127.00	806.50

臺中市	—	—	—	—	—	—	747.00	—	747.00	—
雲林縣	—	—	—	—	—	87.40	136.50	6.0	136.50	93.40
嘉義縣	—	—	38.10	29.80	224.70	—	—	—	262.80	29.80
臺南縣	—	—	—	66.55	—	678.75	—	—	—	745.30
臺南市	—	—	—	—	—	6.71	—	—	—	6.71
高雄縣	—	—	—	739.80	—	899.90	—	—	—	1,639.70
屏東縣	2.95	—	—	697.44	6.60	418.30	—	841.70	9.55	1,957.44
高雄市	1.00	—	—	—	—	66.70	—	—	1.00	66.70
臺東縣	77.00	—	22.40	1,622.92	—	731.70	—	648.00	99.40	3,002.62
花蓮縣	25.90	—	—	107.50	116.00	587.50	21.00	1,634.50	162.90	2,329.50
合計	5,877.84	—	8,050.45	6,116.11	41,799.79	3,879.96	44,444.50	3,509.40	100,172.58	13,505.47

（資料來源：農林廳植物保護科）

二、試驗材料及方法

本菌質病爲黑尾浮塵子（*N. apicalis*）及僞黑尾浮塵子（*N. cincticeps*）所傳播的一種水稻病害，故媒介昆蟲之飼養、病源的接種等操作，槪在尼龍紗木箱（Cage）中進行。箱高及寬各爲2.5台尺，三面爲尼龍紗，一面爲玻璃以利於觀察，箱底固以木板，箱頂亦爲尼龍紗。浮塵子採集自本所農場稻田，置於 Cage 中，飼以臺中65號稻株。病源稻株則爲本所農田第二期作收割後之再生稻病株，於接種前30天餵以病源稻株48小時後取出，經30天後開始接種。接種方法爲先將供試品種在室溫內發芽，播種於大小爲 32×26×12cm 之塑膠盆內，每盆裝土約 6kg ，不施任何肥料，每盆 6 個品種，每品種5～8個苗，苗齡 7 天開始接種，併時時以竹棒擾亂媒介昆蟲，經24小時後取出，妥爲管理，每星期噴藥一次，稻株發病後調査各品種之發病情形。於接種後40多天，病徵始慢慢出現，病徵出現約兩個禮拜，整個供試植株之發病情形還不理想，將其施少量氮肥後宿根，結果發病情形極爲理想。供試品種槪取自稻作硏究室所保存的品種及現正推廣之品種約 200 餘種，惜因六、七月間高溫乾燥，設備不足，帶毒之蟲體先後死亡，故未能將全部供試品種接種。本試驗接種方法得中興大學植物病理系謝式拌珏先生之指導，謹此表示謝忱。

三、試驗結果

表二、供試品種之黃萎病發病率

稻型	供試品種								
	品種來源	品種名稱	發病率%	品種來源	品種名稱	發病率%	品種來源	品種名稱	發病率%
	臺灣	臺農29號	57.1	臺灣	臺北131號	0	臺灣	高雄20號	83.3
	〃	臺農38號	100.0	〃	臺北301號	40.0	〃	高雄136號	100.0
	〃	臺農40號	71.4	〃	臺北306號	83.3	〃	光復401號	83.3
	〃	臺農41號	83.3	〃	臺北310號	0	〃	稗稈稻	85.7
	〃	臺農45號	83.3	〃	新竹24號	83.3	日本	農林49號	0
	〃	臺農51號	75.0	〃	新竹57號	71.4	〃	農林51號	80.0

日本型（稉稻）	臺　灣	臺農60號	85.7	臺　灣	新竹60號	57.1	〃	農林72號	75.0
	〃	臺農選３號	33.3	〃	臺中65號	71.4	〃	中村	57.1
	〃	臺北101號	40.0	〃	臺中150號	100.0	〃	吉神１號	66.7
	〃	臺北102號	85.7	〃	臺中171號	71.4	〃	銀坊主	83.3
	〃	臺北105號	50.0	〃	臺中176號	100.0	〃	相川	80.0
	〃	臺北106號	66.7	〃	臺中181號	40.0	〃	神力	100.0
	〃	臺北108號	42.8	〃	嘉農242號	80.0	〃	盤田朝日	80.0
	〃	臺北109號	62.5	〃	嘉南８號	66.7	〃	愛國	83.3
	〃	臺北110號	33.3	〃	臺南１號	33.3	〃	戰捷	100.0
	〃	臺北111號	80.0	〃	臺南３號	40.0	〃	霜月	100.0
	〃	臺北120號	50.0	〃	臺南４號	80.0	〃	研興育１號	71.4
	〃	臺北123號	50.0	〃	高雄10號	85.7	大　陸	崑山五香稉	66.7
印度型（秈稻）	臺　灣	臺中在來１號	85.7	〃	霜降30—21號	50.0	菲律賓	IR-60-9-3-1	66.7
	〃	臺中秈育７號	71.4	〃	格子20—74號	66.7	〃	IR-8	50.0
	〃	臺中秈育14號	71.4	大　陸	連粘73號	42.8			
	〃	臺中秈育19號	71.4	〃	白早	60.0			
	〃	高雄秈育３號	71.4	〃	全著楊稻	83.3			
	〃	高雄秈育７號	57.1	〃	香谷	66.7			
	〃	矮脚尖	85.7	〃	細谷早稻	28.6			

經檢定之70個水稻品種（品系）調查其發病率之結果如表二所示。此等品種（品系）可以其感病性程度分類如下：

1.發病率100%者：計有戰捷、霜月、臺農38號、臺中176號、臺中150號、神力、高雄136號等７個品種。

2.發病率 70～86%者：計有臺中65號、臺南４號、嘉農242號、高雄20號、銀坊主、相川、盤田朝日、愛國、稗稈稻、新竹24號、高雄10號、臺中秈育７號、臺中秈育14號、臺中秈育19號、高雄秈育３號、研興育１號、臺中在來１號、矮脚尖、農林72號、農林 51 號、光復401號、新竹57號、臺北306號、臺中171號、臺農60號、臺農40號、臺農41號、臺農45號、臺農51號、全著楊稻、臺北102號、臺北111號等32個品種。

3.發病率50～70%者：計有中村、吉神１號、嘉南８號、高雄秈育７號、格仔20—70號、霜降30—21號、 IR 60—9—3— 1、IR—8 號、新竹60號、臺農29號、白早、崑山五香稉、香谷、臺北105號、臺北106號、臺北109號、臺北120號、臺北123號等18個品種。

4.發病率20～50%者：計有臺北301號、臺中181號、臺南１號、臺南３號、臺農選３號、連粘73號、細粒早稻、臺北108號、臺北110號、臺北101號等10個品種。

5.全未發病者（發病率爲零）：計有臺北310號、農林49號及臺北131號等三個品種。

四、結　　論

水稻黃萎病（Yellow dwarf）爲由黑尾浮塵子（*N. apicalis*）及僞黑尾浮塵子（*N. cincticeps*）所傳播的一種菌質病，據農林廳調查結果在本省發生年有增加，且逐漸發展成爲嚴重病害，對稻米之

增產威脅頗大，因此如何來防止該病之發生，實乃目前從事稻作研究工作者的主要課題之一。

筆者等利用尼龍紗木箱（Cage）飼養媒介黑尾浮塵子，進行人工接種，檢定目前正推廣之水稻栽培品種及本系部份保存之品種結果，發現一般水稻品種，不論其爲蓬來稻或爲在來稻，甚或由外地引入之品種（品系），對黃萎病（Yellow dwarf）之抵抗性均弱，在已檢定的70個水稻供試品種中，僅發現臺北310號、臺北131號及農林49號等三個水稻品種之發病率爲零而呈抗病性外，其餘品種之發病率介於28.6%～100%之間，其中有臺農38號、臺中150號、臺中176號、高雄136號、神力、戰捷及霜月等7個品種之發病率高達100%。

按臺北310號之未登記品系名稱前爲臺北早育23號，然據邱人璋氏（1966）報告1960年第二期東勢之稻熱病檢定試驗曾包括臺北育23號，據臺北區農業改良場張場長之口頭解釋，臺北育23號係各區改良場的誤用，應該是臺北早育23號，查臺北早育23號於東勢（1960年第二期）之黃萎病發病率爲42.9%，與本試驗之結果有相當出入，此究竟是否由於病源體之分化，稻種之可能遺傳差異，接種條件之不同或氣象等環境因子之差異所致，則尙有待今後之繼續研究與檢討。

五、參考文獻

1. Virus diseases, Annual Report (1966) IRRI.
2. H. Arthur Lamey (1967) Varietal resistance to Hoja Blanca. A paper at a symposium on the virus diseases of the rice plant. Philippines.
3. Yoshiro Sakurai (1967): Varietal resistance to Stripe, Dwarf, Yellow dwarf and Black-Streaked dwarf. A paper at a symposium on virus diseases of the rice plant. Philippines.
4. Ling K.C. (1968) Major diseases of rice and their control, c, Virus and Virus-like diseases. IRRI Field Experimentati—Workshop.
5. 黑澤英一（1940）：臺灣に發生する稻の萎黃病に就て•病蟲雜27：161～166。
6. 邱人璋（1966）臺灣由黑尾浮塵子傳播的兩種水稻毒素病臺灣植物保護工作昆蟲篇1940～1965。劉廷蔚先生六十歲紀念文集 pp. 279～284。
7. 邱人璋、簡榮和、陳明雄（1966）：兩種浮塵子媒介傳播之臺灣水稻黃萎病，植物保護學會會刊pp. 275～286。

A SCREENING TEST FOR RICE VARIETIES RESISTANT TO YELLOW DWARF DISEASE

by

Shan-Mei Chiu, Ming-Hwa Lin, Chen-Seng Huang

Due to the increasing importance of yellow dwarf disease in Taiwan, a screening test for rice varieties resistant to this disease was initiated at the Institute by use of controlled inoculation techniques. Five to eight seedlings (7 days old) per variety were fed for 24 hours to leaf hoppers including *Nephotettix apicalis* and *N. Cincticeps*, which were acqu-sition-fed with the diseased plants for 48 hours 30 days previously. All feeding was done in cages. About 40 days after the inoculation-feeding, the symptoms appeared on young tillers,

but did not show distinct dwarfing. The testing plants were degenerated about two weeks after the first appearence of symptoms. The new plant arose from stubbles showed typical yellow dwarfing and severe infection with the disease. Among 70 varieties, consisting of ponlai, Taiwan *indica* and Japanses varieties plus a few varieties from China mainland and the philippines, only three varieties, Taipei 310, Taipei 131 and No-lin 49 were free of the disease. Other varieties showed various degrees of infection, ranged from 28.6 percent to 100 percent.

附 註：臺北310號原先調查時、併未發病，但至成熟時期，在少數之新分蘖株上呈病徵其他二品種則無此情形。

At maturing stage of the testing plants, a few new tillers typical of yellow dwarf disease, appeared in Taipei 310, which did not show any symptom of the disease in the above report, while Taipei 131 and No-lin 49 were free of the disease.

水稻宿根栽培方法之研究

（第三報）耕土深淺與不同施肥量對宿根稻之再生力及產量之差異

謝全份•高　樹•江　忠

前　言

深耕可增加耕土層之容積及促進水稻根之發育故水稻生育中期至後期養分吸收充足稈長、穗長、粒數，等均增加，因此產量亦提高。

筆者(1)（1957）在移植稻試驗結果證實此等情形，但在宿根稻之情形是否與移植稻相同則尙待研究。爲探求合理的宿根栽培方法，筆者乃於1959—1961年間將耕土深淺，肥料三要素（N.P.K.）及堆肥施用量等對宿根稻之再生力及產量之影響曾加以探討。今根據三年所得結果加以整理分析報告於後以供參考。

本試驗承蒙徐所長水泉之指導，文成時承謝主任順景，嚴技士盛添，多方斧正協助，併此致謝。

一、試驗材料及方法

將供試品種臺中65號在 10cm(A). 15cm(B). 20cm(C). 25cm(D) ，四種不同耕土深度區下測定，第一期作稻（俗稱前生稻）設五種不同施肥區，如下所示（公斤／公頃）

1. 普通肥料區	堆肥 10,000	硫酸錏 300	過磷酸鈣 300	硫酸鉀 100
2. 一倍堆肥區	堆肥 20,000	硫酸錏 300	過磷酸鈣 300	硫酸鉀 100
3. 一倍氮肥區	堆肥 10,000	硫酸錏 600	過磷酸鈣 300	硫酸鉀 100
4. 一倍磷肥區	堆肥 10,000	硫酸錏 300	過磷酸鈣 600	硫酸鉀 100
5. 一倍鉀肥區	堆肥 10,000	硫酸錏 300	過磷酸鈣 300	硫酸鉀 200

共計20處理，耕土深度爲主區，肥料處理爲副區，隨機排列，重複三次，小區面積爲 $2.5m \times 2m = 5m^2$ 而二期作宿根稻則均用同一施肥量，即硫酸錏300，過磷酸鈣300，硫酸鉀 100（公斤／公頃）。一期作稻收穫時稻椿均留20公分，至施肥，中耕，除草，前再將舊稻椿距地面三公分處割除一次，然後培育爲宿根稻。栽培管理上除特殊處理外均與普通栽培相同，其各種耕作日期如下表：

表1　耕作日期表

期作別／耕作別／年次	第一期作			宿根稻（第二期作）						
	播種	插秧	收穫	割蘖	第1次除草	第2次除草	第3次除草	施肥	害蟲防除	收穫
1959	1月19日	3月10日	7月12日	8月4日	8月18日	8月26日	9月3日	8/9月18/26日	8月20日 9月4日	11月5日
1960	1月16日	3月14日	7月15日	8月14日	8月26日	9月5日	9月12日	8月26日 9月5日	9月7/16日	11月18日
1961	1月20日	3月17日	7月12日	8月2日	8月18日	8月26日	9月6日	8月18/26日	8月20/27日	11月10日

二、試驗結果

（I）不同處理對萌發株數及每株萌芽枝數之影響

舊稻椿刈除前調查各處理小區無萌發株數及每株萌芽枝數之差異，玆將每年由每小區所得調查記錄分別整理合併後分別討論如下。

1. 不同處理對無萌發株數影響

表2. 不同處理對無萌發株數影響之變方分析表　　　　（三年合併）

變異原因	自由度	平方和	均方	F值	理論 0.05	理論 0.01
區集(B)	2	21.6778	10.8589	0.5614	6.94	18.00
年份(Y)	2	307.3445	153.6722	7.9600*	6.94	18.00
Ea	4	77.2222	19.3055	—	—	—
耕土深度(S)	3	118.5056	39.5019	21.9184**	3.16	5.09
SXY	6	96.2044	16.0341	8.8968**	2.66	4.01
Eb	18	32.4400	1.8022	—	—	—
肥料(F)	4	118.2000	29.5500	3.9732**	2.46	3.51
FXS	12	138.6889	11.5574	1.5540	1.85	2.36
FXY	8	38.3500	4 7937	0.6445	2.03	2.69
FXSXY	24	174.7678	7.2820	0.9791	1.63	1.98
Ec	96	713.9833	7.4373	—	—	—
總計	179	1837.3945	—	—	—	—

由上表可知耕土深度，肥料，及年份與耕土深度交感等對無萌發株數有極顯著之影響，年度間之差異亦達顯著標準。今將年度與每小區無萌發株數之關係示如表 3 。

表3. 年份與每小區無萌發株數差異比較　　　　（三年平均）

年份(Y)	平均數	差異	
1961	0.717	(50年)	
1959	1.033	0.316	(48年)
1960	3.633	2.916*	2.600*

L.S.D 5%＝2.2268

1%＝3.6932

由上表可知宿根之萌發與年份不同有顯著之差異，即1960年度每小區無萌發株數最多比1959，1961，年多數倍。

表4. 耕土深度與無萌發株數差異比較　　　　　　　　　(三年平均)

耕土深度 (S) (cm)	平均數	差異		
A (10)	0.555	(A)		
C (20)	1.800	1.245**	(C)	
B (15)	2.000	1.445**	0.200	(B)
D (25)	2.822	2.267**	1.022**	0.822**

L.S.D. 5%＝0.5846
1%＝0.8142

由上表可知耕土深淺對宿根之萌發有極顯著之差異，耕土深度增加極明顯地減少了萌發株數，但15cm 與 20cm 耕深間並無差異。

表5. 不同肥料與每小區無萌發枝差異比較　　　　　　　　(三年平均)

肥料 (F)	平均數	差異			
(1) 普通肥料區	0.944	(1)			
(5) 一倍鉀肥區	1.278	0.334	(5)		
(4) 一倍磷肥區	1.528	0.584	0.250	(4)	
(2) 一倍堆肥區	1.944	1.000	0.666	0.416	(2)
(3) 一倍氮肥區	3.278	2.334**	2.000**	1.750**	1.334*

L.S.D. 5%＝1.2753
1%＝1.6880

由表 5 中可知第一期作施用不同肥料對宿根之萌發之差異極顯著，即第一期作施用多量氮肥者萌發能力極明顯地減少而其他肥料處理間則無差異。

表6. 年份與耕土深度之交感

表土(S) / 年份(Y)	A(10cm)	B(15cm)	C(20cm)	D(25cm)	計
1959	+ 0.34	− 0.91**	+ 0.63	− 0.06	+− 0.00
1960	− 1.06**	+ 1.56**	− 0.71*	+ 0.21	+− 0.00
1961	+ 0.72*	− 0.66*	+ 0.07	− 0.15	− 0.02
計	+− 0.00	− 0.01	− 0.01	+− 0.00	− 0.02

L.S.D. 5%＝0.665
1%＝0.911

由表 6 .年份與耕土深度之交感情形看來 10cm 者於1960、1961，兩年達顯著標準，15cm 者三年均達極顯著或顯著程度，20cm者則只1960年達顯著標準，25cm 者則三年均不顯著。同時1960年之交感值却與1959、1961兩年者相反。此可能爲49年度之氣象因子與48、1961年度不同故其交感作用有相反之傾向。

2. 不同處理對每株萌芽枝數之影響

表7. 不同處理對每株萌芽枝數影響之變方分析表 (三年合併)

變異原因	自由度	平方和	均方	F值	理論 0.05	理論 0.01
區集(B)	2	28.8130	14.4065	2.4779	6.94	18.00
年份(Y)	2	1591.4041	795.7020	136.8604**	6.94	18.00
Ea	4	23.2559	5.8140	—	—	—
耕土深度(S)	3	99.5075	33.1692	3.3407*	3.16	5.09
SXY	6	110.3018	18.3836	1.8516	2.66	4.01
Eb	18	178.7151	9.9286	—	—	—
肥料(F)	4	67.6662	16.9165	0.0700	2.46	3.51
FXS	12	54.5098	4.5425	0.0188	1.85	2.36
FXY	8	7.9519	0.9940	0.0041	2.03	2.69
FXSXY	24	47.0994	1.9625	0.0081	1.63	1.98
Ec	96	23182.0478	241.4797	—	—	—
總計	179	25391.2725	—	—	—	—

上表顯示不同年份有極顯著之差異，耕土深度之影響亦達顯著標準，其餘各因子未達到顯著標準。茲將年份及耕土深度再進一步分析，分別示如表8，9。

表8 .年份與每株萌芽枝數之比較 (三年平均)

年份(Y)	平均枝數	差異	
1959	8.6158	(48年)	
1960	9.7867	1.1709	(49年)
1961	15.4650	6.8492**	5.6783**

L.S.D. 5% = 1.2220
1% = 2.0268

由舊稻椿所萌發芽數，1959，1960，兩年度無差異，但1961年却較前兩年有極顯著之增加現象。

表9. 耕土深度與每株萌芽枝數之比較 (三年平均)

耕深度(S) (cm)	平均枝數	差異		
C (20)	10.3855	(C)		
D (25)	10.9478	0.5623	(D)	
B (15)	11.5033	1.1178*	0.5555	(B)
A (10)	12.4000	2.0145**	1.4522**	0.8967

L.S.D. 5% = 0.9868
1% = 1.3517

由表9中可知淺耕者（10cm）較深耕者（20,25cm）其萌發枝數有極顯著之差異。但與15cm耕深者無差異，而15cm耕深者與20cm耕深者之間達5%顯著程度，但與25cm耕深者無差異。

由上面之結果可知舊稻椿之萌發力即其再生力與耕土深度及不同肥料處理間之差異極顯著而同一處理中年份之不同其差異亦不同，故宿根稻之再生力受氣象因子之左右極爲明顯。

（Ⅱ）不同處理對稈長，穗數之影響

各處理區於收穫前調查20株之稈長，穗數，茲將三年結果整理後經變方分析結果分別加以說明如下。

1. 不同處理對稈長之影響（不包括穗長）

表10　不同處理對稈長變方分析表　　（三年合併）

變異原因	自由度	平方和	均方	F 値	理論 0.05	理論 0.01
區集(B)	2	67.8408	33.9204	2.1636	6.94	18.00
年份(Y)	2	12145.0405	6072.5202	387.3374**	6.94	18.00
Ea	4	62.7104	15.6776	—	—	—
耕土深度(S)	3	433.0803	144.3601	6.7951**	3.16	5.09
SXY	6	387.6797	64.6133	3.0414*	2.66	4.01
Eb	18	382.4059	21.2448	—	—	—
肥料(F)	4	70.2944	17.5736	0.0014	2.46	3.51
FXS	12	93.4744	7.7895	0.0006	1.85	2.36
FXY	8	85.3382	10.6673	0.0008	2.03	2.69
FXSXY	24	178.8930	7.4539	0.0006	1.63	1.98
Ec	96	1201077.9444	12511.2286	—	—	—
總計	179	1214984.7020	—	—	—	—

由上表可知年份及耕土深度對稈長之影響差異極顯著，同時兩者之交感作用亦達顯著，其餘各處理則均未達顯著標準。

表11.　各年份中稈長差異比較　　（三年平均）

年份	平均數 (cm)	差異	
1960	73.46	(49)	
1961	78.50	5.04**	(50)
1959	92.85	19.39**	14.35**

L.S.D.　5%＝2.0068

1%＝3.3282

三年間其稈長之差異均極顯著，由此可知宿根稻之生育受氣象因子之影響很大。

表12 耕土深度對稈長差異比較 (三年平均)

耕 土 深 度	平 均 數 (cm)	差		異
B (15cm)	79.79	(B)		
A (10cm)	80.49	0.70	(A)	
C (20cm)	82.41	2.62*	1.92	(C)
D (25cm)	83.71	3.92**	3.22**	1.30

L.S.D. 5%=2.0415
1%=2.7965

由上表可知增加耕土深度能助稈長增加，此與移植稻相似。其中耕土深度25cm者除與 20cm 者無差異外，較15cm—10cm者有極顯著之增加。20cm者較 15cm 者亦有差異，其餘則均未達顯著標準。

2. 不同處理對穗數之影響

表13. 不同處理對穗數影響之變方分析表 (三年合併)

變 異 原 因	自 由 度	平 方 和	均 方	F 值	理	論
					0.05	0.01
區 集 (B)	2	4.0538	2.0269	0.6913	6.94	18.00
年 份 (Y)	2	209.2141	104.6070	35.6801**	6.94	18.00
Ea	4	11.7272	2.9318	—	—	—
耕 土 深 度 (S)	3	39.3158	13.1053	6.3252**	3.16	5.09
SXY	6	27.2645	4.5441	2.1932	2.66	4.01
Eb	18	37.2937	2.0719	—	—	—
肥 料 (F)	4	15.4692	3.8673	0.0198	2.46	3.51
FXS	12	26.4870	2072	0.0113	1.85	2.36
FXY	8	23.5515	2.9439	0.0151	2.03	2.69
FXSXY	24	29.1643	1.2152	0.0062	1.63	1.98
Ec	96	18727.4189	195.0773	—	—	—
總 計	179	19150.9600	—	—	—	—

由上表可知不同處理對宿根稻穗數之影響概略地與稈長相似，即年份及耕土深度極顯著，其餘各因子則未有顯著之影響。

表14 各年份中穗數差異比較

年 份	平 均 數	差	異
1 9 5 9	9.223	(48年)	
1 9 6 1	9.702	0.479	(50年)
1 9 6 0	11.712	2.489**	2.010**

L.S.D. 5%=0.8678
1%=1.4392

由上表14得知1960年度較其他兩年有極顯著之增加，1959年與1961年間則無差異。

表15. 耕土深度與穗數相差比較　　　(三年平均)

耕深度 (cm)	平均數	差		異
A (10)	9.789	(A)		
B (15)	9.969	0.180	(B)	
C (20)	10.091	0.302	0.122	(C)
D (25)	11.000	1.211**	1.031**	0.909**

L.S.D. 5%=0.637

1%=0.873

由上表可知宿根稻之穗數依耕土深度增加而增加其差異情形爲 25cm 與其他深度間達極顯著。其他處理間則無差異。

由上述結果可知不同處理對宿根稻之稈長，穗數之差異其耕土深淺及年份之影響均極顯著，而稈長與穗數兩者的消長有相反之傾向，即稈長增長之場合穗數減少，穗數增加之場合稈長減少，此種情形與普通移植稻相同。

(Ⅲ) 不同處理對產量之影響

表16. 不同處理對產量影響之變方分析表　　　(三年合併)

變異原因	自由度	平方和	均方	F 值	理論 0.05	理論 0.01
區集(B)	2	671034.4445	335517.2222	0.3694	6.94	18.00
年份(Y)	2	20967854.4445	10483927.2222	0.1154	6.94	18.00
Ea	4	3632518.8888	908129.7222	—	—	—
耕土深度(S)	3	2103260.0000	701086.6667	28.5437**	3.16	5.09
SXY	6	2986136.6666	497689.4444	20.2627**	2.66	4.01
Eb	18	442113.3335	24561.8519	—	—	—
肥料(F)	4	559738.8889	139934.7222	0.0441	2.46	3.51
FXS	12	242234.4444	20186.2037	0.0064	1.85	2.36
FXY	8	250484.4444	31310.5555	0.0099	2.03	2.69
FXSXY	24	864102.2223	36004.2593	0.0113	1.63	1.98
Ec	96	304582522.2221	3172734.6065	—	—	—
總計	179	337302000.0000	—	—	—	—

由表16. 觀之耕土深度及年份與耕土深度交感極顯著，其他如肥料及年份等均無顯著之差異，茲將耕土深度及年份和耕土深度之交感作用，進一步之分析。

表17. 耕土深度主效應 (三年平均)

耕土深度 (cm)	平均產量 (kg/ha)	差		異
B (15)	1150.000	(B)		
C (20)	1256.666	106.666**	(C)	
A (10)	1320.222	170.222**	63.556	(A)
D (25)	1448.666	298.666**	192.000**	128.444**

L.S.D. 5%－69.417
1%＝95.089

由上表可知深耕區（D25cm）產量最高，較其他各處理均有極顯著之差異。其餘除耕土深度10cm與 20cm者無差異外其他各處理間之差異亦達極顯著標準。

表18. 年份與耕土深度交感作用

表土(S) 年份(Y)	A		B		C		D		計	
1959	－	113**	＋	67	－	91*	＋	140**	＋	3
1960	＋	276**	－	116**	－	52	－	109**	－	1
1961	－	161**	＋	50	＋	143**	－	31	＋	1
計	＋	2	＋	1	＋－	0	＋－	0	＋	3

L.S.D. 5%＝ 77.610
1%＝106.313

由上表觀之耕土深度與年份交感作用因年份之不同，呈現出不同的差異。

三、討論及結論

筆者(1)（1967）由試驗得知耕土容積可左右普通移植稻之產量，而宿根稻之情形由上述試驗結果亦得證明有明顯之差異。

稻之再生力與耕土深度間顯然是淺耕者較好，據本試驗每小區無萌發株數即缺株數最多者爲深耕區（D25cm）2,822株，最少者爲淺耕區（A, 10cm）0.555株，兩者之相差達五倍以上，而每株萌芽枝數最多者爲淺耕區（A10cm）12,400枝，最少者爲深耕區（C.D. 20—25cm）10,385—10,948枝兩者相差1—2枝，因此可說淺耕之稻椿復發新根較快，初期之再生力較强，而到中、後期因耕土容積少加上宿根栽培沒有耕鋤和整地，故土壤極堅密，施下之肥料容易流失難以保留土壤中，其情形尤以淺耕者爲甚。故到中後期缺乏養分阻害萌出分蘗之生長，或形成無效分蘗。如表（12）表（15）所示稈長，穗數，均隨耕土深度增加而增加，似與再生力有相反之傾向。此點可知耕土深淺對初期萌出分蘗有明顯之影響所助長後期的生植機能之表現。

宿根之再生力與年份亦有明顯之差異，在本試驗中再生力最高者爲50年（1961）最低者爲49年（1960）似因兩年間之氣象因子不同，影響稻椿萌發機能所致，而何種因子影響最大則須進一步之探討。

前生稻施用不同肥料處理只多氮區(3)增加缺株，其餘處理均無差異，前生稻多施氮量使稻之莖葉

繁茂而軟弱故易失再生之能力，稻椿亦容易枯死，因而明顯地使缺株增加。此與筆者(2)（1959）第一報情形相同。至於產量，前生稻氮肥施用之多少並無明顯的效果表現。

可見前生稻之殘留肥分極微無法影響宿根稻之中後期生育與生殖機能。

在本試驗中產量最高者（如表17）爲耕土深度25cm(D區），淺耕10cm（A區），次之，但淺耕（A區），稻之再生力較强，初期具有優異的高產潛力，然而未能獲最高產量可能是所萌發分蘖在耕土容積較少之環境下難以充分發育，致使無效分蘖增加之故。深耕25cm 區稻之再生力最差，而產量却最高，此可能是所萌發分蘖，得有較大耕土容積及營養，能充分發育，無效分蘖減少，到中後期生育環境仍很良好之故。此點可由收穫前所調查各小區20株之穗數與稈長之情形得到證明，故宿根稻之產量靠中、後期之生育環境而定。即知耕土深度對宿根稻有如此密切之關係，故如何提高深耕後宿根栽培稻之再生力，是值得研究之問題。

爲保持宿根稻，萌芽中後期之生育健全提高產量，玆將改進之幾點提出如下：

1. 改進施肥方法：分次施用肥料以防流失。
2. 增加施肥量：在宿根生育中因肥分容易流失，到生育中後期常表現出缺肥現象，故應增施20—30%氮鉀肥以促進生育。總而言之，提高稻椿之再生力及培育健全之萌芽枝是爲提高宿根稻產量上最重要之事項。

摘　　要

1. 爲探討四種不同耕土深度與不同肥料對宿根稻之再生力及產量影響而進行此研究。
2. 宿根稻之再生力有依耕土深度之增加而減低之傾向。
3. 前生稻施用多氮時有減少再生力之傾向。
4. 宿根稻之稈長及一株穗數均依耕深度增加而增加。
5. 宿根稻之收量以深耕 25cm 區最高。

參　考　文　獻

1. 謝全份（1957）耕鋤深淺，施肥量及施肥法對水稻產量之影響。（農業研究第 7 卷第 3 期）
2. 謝全份（1959）水稻宿根栽培方法之研究（第一報）（農業研究第 8 卷第3.4.期）
3. 謝全份（1964）水稻宿根栽培方法之研究（第二報）（農業研究第13卷第 3 期）
4. 王啓柱（1938）甘蔗品種新植與宿根栽培之比較研究。（中華農學會報新第10期）
5. 汪呈因（1954）臺灣再生稻栽培之研究。（臺灣農林 8 卷 8 期）
6. 川瀨惣次郎著（1922）土壤學
7. 川瀨惣次郎著（1921）肥料學
8. 手島寅雄著（1951）栽培學（耕種編）

STUDIES ON THE CULTIVATION OF RATOONED RICE

III. Effect of Plowing Depth and Amount of Fertilizer on the Reviability and Yield of Ratooned Rice

By

C. F. Hsieh, S. Kao and C. Chiang

Summary

In order to obtain knowledge of the effects of plowing depth and the amount of fertilizer on the reviability and yield of ratooned rice the experiment was conducted in Taiwan Agricultural Research Institute during 1959-1961. The results obtained are as follows:

1. The reviability of ratooned rice tended to decrease when the plowing depth is increased.
2. When the high amount of nitrogen fertilizer was applied in the former crop the reviability of rice ratooning was markedly reduced. It was found to be due to weakening of the plants caused by the excess fertilizer in the soil.
3. When the plowing depth was increased, the elongation of the culm length and the increase of panicle number per plant were noticed.
4. The highest grain yiled was obtained from the 25cm plowing depth plot.

EFFECT OF KNOXWEED ON THE CONTROL OF WEEDS IN PADDY RICE

W. L. Chang*

Knoxweed, a new herbicide of Eptam+MCPA mixture produced by the Stauffer Chemical Company has been under testing for its effect on weed control in transplanted rice in Taiwan since 1967. Exprimental results so far available indicated that weed control effect of this chemical was rather variable. Tang and Tsai (1967) reported that Eptam + MCPA gave good control of both grass and broad-leaved weeds, but experiments conducted at Hsinchu and Taichung showed a poor control of weeds in transplanted rice (PDAF, 1967). Additional testing on this chemical is, therefore, necessary. The purpose of this experiment was to compare several combinations of Eptam+MCPA on the control of weeds in the first crop of rice.

MATERIALS AND METHODS

The experiment was conducted in the first crop (dry season) of 1968 at Tai-tou-ken Farm of the Chiayi Agricultural Experiment Station. Soil of the experimental plots was silty clay loam and pH, organic matter, available P_2O_5 and K_2O of the surface soil were 5.8, 1.80%, 229 kg, and 98 kg per ha, respectively. A *Japonica* rice variety, Chianung 242 was subjected to 12 treatments as listed in Table 1.

Table 1. The application rates, formulation, and time of application of various treatments.

Treatment	Active rate (kg/ha)	Formulation	Time of application
1. Knoxweed (Eptam+MCPA)	2.00+0.8	4.0%+1.6%G	6 days after transplanting
2. Knoxweed (Eptam+MCPA)	2.00+0.6	4.0%+1.2%G	6 days after transplanting
3. Knoxweed (Eptam+MCPA)	2.00+0.4	4.0%+0.8%G	6 days after transplanting
4. Knoxweed (Eptam+MCPA)	1.75+0.8	3.5%+1.6%G	6 days after transplanting
5. Knoxweed (Eptam+MCPA)	1.75+0.6	3.5%+1.2%G	6 days after transplanting
6. Knoxweed (Eptam+MCPA)	1.75+0.4	3.5%+0.8%G	6 days after transplanting
7. Knoxweed (Eptam+MCPA)	1.50+0.8	3.0%+1.6%G	6 days after transplanting
8. Knoxweed (Eptam+MCPA)	1.50+0.6	3.0%+1.2%G	6 days after transplanting
9. Knoxweed (Eptam+MCPA)	1.50+0.4	3.0%+0.8%G	6 days after transplanting
10. Unweeded Check	—	—	—
11. Hand weeded Check	—	—	3 times
12. TOK (Check)	2.0	7%G	6 days after transplating

* The writer wishes to thank Professor Stassen Y. G. Soong, Far East Representative of the Stauffer Chemical Company, for his kind help during the course of this experiment.

The design of the experiment was a randomized complete block with 3 replications. The plot was 2.5 x 6.0 m in size from which 1.0 x 4.0 m or 4 m^2 was harvested for yield determination. The plant spacing was 25 x 20 cm with approximately 5 seedlings being transplanted at each hill. Ammonium sulphate, calcium superphosphate, and potassium sulphate was used as carriers of N, P_2O_5, and K_2O which were applied at the rate of 100, 50, and 50 kg per ha, respectively. Herbicides were applied to a shallow (2-3 cm) flood of water by broadcasting and the same level of water was maintained for about 10 days after the application of herbicides.

Weed control was recorded in percentage at 2, 4, and 8 weeks after application of herbicides. Phytotoxicity to rice was also recorded in percentage once a week started from one week after herbicide application. Dwarf and wilted rice plants were also counted. Dry weed weight per plot was taken at the time of harvesting.

The weather in the early stage of rice growth was cold, dry, and sunny, but hot and rainy weather prevailed during the late growing stage. The climatic data of the whole rice growth are presented in Table 2.

Table 2. Climatic data of the Chiayi Agricultural Experiment Station during the period of the experiment.

Ten-day Period	Rainfall amount (mm)	Number of rainy days	Number of sunshine hours	Relative humidity (%)	Temperature (°C)		
					Maximum	Minimum	Mean
March 1—10	0	0	64.4	64	22.3	12.4	17.4
11—20	0	0	42.0	64	26.4	17.1	21.7
21—31	178.4	9	9.8	79	24.4	17.3	20.9
April 1—10	1.9	2	32.1	73	26.4	19.3	22.9
11—10	0.9	2	15.8	74	26.9	19.2	23.1
21—30	16.8	2	40.7	67	25.8	15.9	20.9
May 1—10	0	0	29.7	63	29.9	20.9	25.4
11—20	0	0	25.6	60	31.2	22.9	27.0
21—31	245.4	9	3.3	82	29.3	24.0	26.7
June 1—10	125.2	7	41.5	77	30.0	22.5	26.3
11—20	314.6	5	13.5	68	31.2	23.5	27.4
21—30	149.4	6	45.3	65	31.3	24.3	27.7
July 1—10	141.1	5	47.9	66	32.0	25.4	23.7

RESULTS AND DISCUSSION

Weed Control Effect

The number of weeds counted at the time of herbicides application revealed that the infestation of weeds in the experimental plots at the early stage of rice growth was mostly the broad-leaved weeds (Table 3). The most common broad-leaved weeds in the plots were

Monochoria vaginalis, Dopatrium junceum, Marsilea quadrifolia, Lindernia pyxidaria, and *Eclipta prostrata.* The grasses were predominately *Echinochloa crusgalli* and *Paspalum scrobiculatum,* whereas *Cyperus difformis,* and *Cyperus iria* were the predominant sedges.

The number of weeds counted at 2, 4, and 8 weeks after the application of herbicides indicated that various Eptam + MCPA combinations gave good control of weeds, including grasses, broadleaves, and sedges. The results were similar to those reported by Tang and Tsai (1967). When expressed by the percentage of weed control of the plot, Eptam+MCPA combinations gave more than 90% weed control at 2 and 4 weeks after the application of herbicide and more than 70% weed control at 8 weeks after the application of herbicide which were higher than those of hand weeded check and TOK (Table 4). Both weed counting and percentage of weed control indicated that weed control effects of various Eptam+ MCPA combinations could last for one to two months. Since weed competition with rice was reported to be most serious during the first 30 days after the emergence of weeds (Shaw and Danielson, 1961), Eptam+ MCPA appears capable of preventing weed injury during the most critical period of rice growth. The weed control effects of various Eptam+ MCPA combinations varied slightly suggesting that good control of weeds may be obtained with the lowest rates of Eptam and MCPA (1.50 and 0.4 kg per ha, respectively) and it seems economically unfeasible to apply Eptam and MCPA higher than these rates.

Dry weight of weeds taken at the time of harvesting is also presented in Table 4. Although dry weight of weeds showed poor agreement with weed control effect, treatments with good weed control were found to be generally associated with low dry weed weight.

Table 3. Number of weeds per m^2 counted at different times.

Treatment	At the time of herbicide application				2 weeks after herbicide application			
	Grasses	Broad leaves	Sedges	Total	Grasses	Broad leaves	Sedges	Total
1	16	64	27	107	0	0	0	0
2	11	37	32	80	0	37	0	37
3	11	91	53	155	0	0	0	0
4	5	128	91	224	0	5	0	5
5	0	75	53	128	0	48	0	48
6	0	75	64	139	0	16	0	16
7	0	171	64	235	0	0	0	0
8	5	101	128	234	0	64	0	64
9	0	91	48	139	0	0	0	0
10	5	117	27	149	11	283	0	294
11	0	101	133	234	0	11	0	11
12	0	53	69	122	0	11	32	43
Mean	4	92	66	162	1	40	3	43

Table 3. Number of weeds per m² counted at different times. (countinued)

Treatment	4 weeks after herbicide application				8 weeks after herbicide application			
	Grasses	Broad leaves	Sedges	Total	Grasses	Broad leaves	Sedges	Total
1	0	0	0	0	0	336	21	357
2	0	11	37	48	0	267	69	336
3	0	43	11	54	0	363	43	406
4	0	48	0	48	0	485	59	544
5	0	32	0	32	0	309	37	346
6	0	32	11	43	0	389	22	421
7	0	107	0	107	0	523	16	539
8	0	32	11	43	0	411	27	438
9	0	11	0	11	0	219	21	240
10	13	256	11	280	16	731	5	752
11	0	64	0	64	0	165	0	165
12	0	37	43	80	16	368	48	432
Mean	1	56	10	67	3	381	31	415

Table 4. Percentage of weed control and dry weed weight at the time of harvesting.

Treatment	Weed control (%)			Dry weed weight (g/m²)			
	2 weeks	4 weeks	8 weeks	Grasses	Broad leaves	Sedges	Total
1	94	97	73	0	56.0	20.8	76.8
2	92	91	72	116.8	30.4	211.2	358.4
3	92	94	77	0	91.2	8.0	99.2
4	87	95	68	22.4	59.2	86.4	168.0
5	89	88	78	28.8	64.0	40.0	132.8
6	87	92	74	97.6	72.0	8.0	177.6
7	97	92	74	168.0	46.4	80.0	294.4
8	97	95	78	267.2	57.6	68.8	393.6
9	94	93	78	0	46.4	84.8	131.2
10	0	0	0	89.6	73.6	78.4	241.6
11	42	77	65	0	16.0	0	16.0
12	37	43	32	30.4	30.4	238.4	299.2

Phytotoxicity to Rice

The percentage of rice toxicity, rice plants showing dwarf symptom or completely killed, are presented in Table 5. Rice pants began to show phytotoxicity symptoms one week

Table 5. Phytotoxicity of herbicides to rice.

Treatment	Phytotoxicity percentage (%)				Dwarf plants (hill)			Plants killed (hill)		
	Weeks after herbicide application				Weeks after herbicide application			Weeks after herbicide application		
	1	2	6	8	2	6	8	2	6	8
1	37	32	35	27	49	23	14	1	5	6
2	17	18	18	10	36	10	8	1	4	4
3	17	17	13	5	42	12	9	0	2	2
4	32	25	33	17	36	18	9	2	4	4
5	25	20	23	8	31	10	8	1	1	2
6	13	17	7	2	13	12	6	0	0	0
7	37	33	33	13	51	18	7	2	5	5
8	35	43	42	27	81	27	12	2	6	6
9	10	13	12	3	23	9	8	1	2	2
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0

after the application of Eptam+ MCPA. At first, the phytotoxicity was manifested mostly by chlorosis, stunting, and dwarf seedlings, but with the progress of time, the most seriously affected plants stopped to grow and eventually killed. Although the degree of Phytotxicity gradually decreased with the growth of rice plant, rice toxicity was still evident even at 8 weeks after herbicide application. The phytotoxicity of Eptam+ MCPA was also observed by Tang and Tsai (1967) and other stations (PDAF, 1967).

It was of interest to note that that the phytotoxicity of Eptam + MCPA to rice increased with rates of MCPA but varied slightly with rates of Eptam, indicating that MCPA seems to be the component responsible for the high toxicity of the herbicide, knoxweed. It appears, therefore, that the rate of MCPA should be reduced to the mimimum necessary for good control of weeds, if the phytotoxicity of knoxweed to rice is to be improved. Tang and Tsai (1967) suggested the that active rate of MCPA should not exceed 0.2 kg per ha. It was also found that MCPA applied at 15 days after transplanting caused no toxicity to rice (Chang 1968). Thus, it seems highly likely that phytotoxicity of Eptam +MCPA can be reduced if it is applied at 2 weeks instead of at one week after the transplanting. No phytotoxicity to rice was detected for TOK treatment.

Rice Growth and Grain Yield

Plant height was shorter and average number of tillers per hill was smaller in Eptam

+ MCPA treatments when compared with those of hand weeded check at 50 days after transplanting, showing that Eptam + MCPA inhibited the growth of rice at the the early stage (Table 6).

Table. 6 Effect of knoxweed on the growth and grain yield of rice.

Treatment	At 50 days after transplanting		At maturity stage		Heading date	Grain yield	
	Plant height (cm)	Number of tillers per hill	Plant height (cm)	Number of panicles per hill	(days)	(kg/ha)	(%)
1	67.9	13.6	111.7	11.4	87	3,980	70.7
2	69.8	13.8	111.8	10.4	86	4,604	81.8
3	71.6	14.7	113.2	11.1	86	4,760	84.6
4	67.3	13.6	114.8	11.1	87	4,560	81.1
5	69.8	14.7	111.9	10.6	85	4,584	81.5
6	70.2	13.7	108.5	10.5	84	4,554	81.0
7	68.9	12.4	113.4	10.4	87	4,546	80.8
8	67.7	12.7	113.0	10.7	87	4,620	82.1
9	69.6	12.5	112.1	10.0	85	4,946	87.9
10	71.2	13.8	110.3	9.7	83	4,580	81.5
11	71.4	15.0	114.6	11.0	83	5,626	100.0
12	71.3	14.2	111.0	9.6	83	4,666	82.9
Mean	69.7	13.7	112.2	10.5	85	4,669	83.0

However, the growth of rice plants recovered gradually and practically no differences in plant height and number of panicles per hill were observed between Eptam + MCPA and hand weeded treatments at maturity stage. The heading date of rice plants was delayed considerably by the application of Eptam + MCPA. It was found that treatments with severe phytotoxicity of rice generally headed late, indicating that slow recovery from the chemical injury was the major factor responsible for delayed heading of rice.

Hand weeded check produced the highest yield whereas Treatment 1 with highest rate of Eptam + MCPA gave the lowest yield which was 29.3% less than that of the hand weeded check (Table 6.) Grain yields of most of the Eptam + MCPA treatments were similar to that of unweeded check which was 18.5% lower than that of the hand weeded treatment. The low yield of Eptam + MCPA treatments may be attributable to their severe phytotoxicity to rice whereas that of unweeded check, to weed competition.

It was found that applications of Eptam 2 kg + MCPA 0.4 kg per ha (Treatment 3) and Eptam 1.5 kg + MCPA 0.4 kg per ha (Treatment 9) outyielded the recommended chemical, TOK (Treatment 12) by 2.1 % and 6.2%, respectively. The higher grain yield production of these treatments may be due largely to their better control of weeds than that of TOK. If the phytotoxicity of Eptam + MCPA can be improved by reducing the rate of MCPA or adjusting the time of application, it appears highly probable that this chemical

may become a good herbicide for paddy rice.

SUMMARY

Several combinations of Knoxweed (Eptam + MCPA) were evaluated for their weed control effect at the Chiayi Agricultural Experiment Station in the first crop of 1968. All treatments of Eptam + MCPA were found to be highly effective in controlling weeds in paddy rice and its effect was found to last more than 8 weeks after the application of this chemical. However, Eptam+ MCPA caused severe phytotoxicity to rice. Rice toxicity was found to be related to the rate of MCPA, the higher the MCPA rate, the heavier the rice toxicity. As a result, grain yields of all Eptam + MCPA treatments were 12.1 to 29.3% lower than that of hand weeded check.

LITERATURE CITED

1. Chang, W.L. 1968. Weed control effect of some herbicides in paddy field. Jour. Taiwan Agr. Res. 17(2):15-25.
2. Provincial Department of Agriculture and Forestry, Taiwan Provincial Government. 1967. Annual Report of Plant Protection. pp. 243-280.
3. Shaw. W.C. and L. L. Danielson, 1961. The control of weeds in seed crops. The year book of Agriculture, pp. 280-287.
4. Tang, W. T. and W. F. Tsai 1967 Testing of some herbicides in paddy field. Sci Agr. 15(11, 12): 341-344.

水田殺草劑 Knoxweed 之治草效果

張 萬 來

摘 要

有效成份含量不同之 Knoxweed 若干種經本分所於57年第一期作水稻田試驗結果，發現不同成分之處理均具優良之治草效果，但因對水稻之藥害極爲嚴重，其每公頃稻谷產量僅達人工除草區之71～88%。

放射線誘發突變稻品系之糙米粗蛋白質含量

陸培基　黃真生

一、緒　　言

本省水稻之栽培歷年來發展神速，惟多着重於多產、抗病、耐肥等品種之育成。至於品質方面之改良工作則至今少見付之實行者。值此缺乏營養食糧供應之今日，除了研究如何提高糧食作物之產量外，研究如何提高營養分含量乃是一件刻不容緩之工作。

查林等（1962）曾測定全省主要稻品種糙米之粗蛋白質含量，並指出蓬萊稻品種之含蛋白質量於第一期作變異於7—9%之間，平均爲 8.34%，於第二期作則爲 7.5—10.5 %之間，平均爲 8.55%（均爲Oven-dry basis）。一般說在臺灣越向北，糙米的含蛋白質量有越高之傾向，又在來稻蛋白質的含量有比蓬萊稻高之傾向。國際稻米研究所（1966）由保存全世界稻種 8,500 品種中抽出 4,023 樣本，並報告其糙米之蛋白質含量變異於5.6—18.2%之間，平均爲9.9±1.8%均爲（wet basis)。

Tamura 等（1968）報告日本實用品種之蛋白質含量變異於5.3—9.3%之間，並由 γ—線處理農林 8 號後代所得之矮性突變種其含蛋白質量爲10—12%之間，此爲原品種之含蛋白質量之170—200%。

本試驗使用民國47—50年前後所擧行的放射線突變育種計劃所得，並保存的 107個突變品系，做糙米的粗蛋白質含量之調查。本工作於民國56年中開始到57年中才完成，其間包括化學分析人員之訓練。本試驗的化學分析方法，得本所農化系李蘭帝先生指導，謹此表示謝忱。

二、試驗方法及材料

由臺中65號，臺中155號，高雄27號，嘉南 8 號及嘉農242號等五個水稻品種之休眠種子經 γ—線及熱中子處理後代分離之 107 突變品系爲研究材料。將此 107 個品系之糙米分別磨成粉狀，以 Kjedahl 氏法定其氮量，惟氨之定量乃依擴散法將樣品經濃硫酸加熱分解處理後，注入 NaOH 之飽和液，使其逸出之氮被吸收於硼酸液中，然後以 0.01 N 之標準酸液滴定之。 由消耗之酸液計算氮量，再換算爲粗蛋白含量（李蘭帝1966,1968）。

三、試　驗　結　果

表一、107個突變品系之粗蛋白質含量（Oven-dry basis）

特性 / 品種品系 Mutant. No.	突變體來源 Origin of mutants	粗蛋白質含量% Crude protein %	1964　1 植　高 Plant height	有效分蘖 No. of tillers	備　註 Remarks
變 1	65—O	10.21±0.2335*	53.4	9.7	穗重一克以下
2	65—O	8.68±0.2464	74.5	15.4	

3	65—B	7.97±0.4365**	83.1	12.1	穂重一克以下
4	65—A	9.66±0.2456	66.8	19.4	
5	155—A	9.71±0.1905	70.7	19.6	
6	65—A	9.22±0.2469	47.0	10.9	
7	8—D	9.71±0.4220	50.6	11.5	
8	8—D	10.35±0.3101	50.1	13.0	
9	8—D	11.08±0.4903**	53.9	8.4	
11	27—D	11.42±0.2346	89.3	9.3	
12	27—D	11.42±0.2346	92.6	9.6	
13	65—A	5.64±0.1082	55.7	75.4	穂重一克以下
14	242—C	5.45±0.1302	53.9	65.3	穂重一克以下
15	65—A	9.89±0.5518**	65.6	16.0	
16	65—C	9.86±0.1986	64.4	14.4	
17	155—C	9.83±0.5887**	74.7	16.4	
18	65—C	8.16±0.4095**	66.7	14.6	
19	65—B	8.72±0.5673**	73.9	12.2	
20	65—D	9.09±0.4938**	70.8	13.8	
21	8—C	8.22±0.0235	65.6	14.0	
22	27—D	9.50±0.1125	64.6	17.0	
23	242—A	8.12±0.1502	66.9	14.6	
24	242—B	8.02±0.6201**	91.9	8.5	
25	27—D	8.17±0.1963	82.9	11.8	
26	27—D	8.96±0.1808	74.1	13.8	
27	27—D	7.81±0.2494**	78.4	9.8	
28	8—D	7.27±0.1212	78.0	13.1	
29	27—C	8.47±0.1271	80.6	12.3	
30	8—D	8.52±0.1570	76.6	13.6	
31	8—C	7.87±0.1271	81.6	11.9	
32	65—D	7.49±0.1710	93.9	12.6	
33	155—D	8.61±0.0071	96.3	10.5	
34	155—C	9.74±0.0897	79.5	6.9	
35	27—D	8.56±0.0809	82.2	9.9	
36	65—D	7.39±0.0173	86.0	11.2	
37	155—B	9.33±0.0866	91.5	10.5	
38	8—A	9.44±0.2989**	94.9	10.5	
39	8—D	7.15±0.0982	88.3	13.5	
40	8—C	8.63±0.1212	93.0	11.5	

41	242—C	9.03±0.1862	102.0	10.6	
43	27—D	9.10±0.4753**	78.5	15.5	穗重一克以下
44	27—C	8.34±0.1155	83.2	21.8	
45	27—B	10.59±0.3195**	72.7	12.7	
46	65—C	9.58±0.1168	106.5	11.1	
47	27—B	10.22±0.3176	100.8	9.4	
48	155—C	7.56±0.2265**	73.6	18.0	
49	65—D	6.94±0.3358**	69.3	16.1	
50	155—A	6.23±0.0579	76.1	18.4	
51	27—D	7.69±0.1427	70.8	19.0	
53	27—D	7.74±0.1098	67.7	19.4	
54	8—D	7.00±0.1617	67.4	19.5	
55	65—B	7.24±0.1458	90.4	12.3	
56	65—B	8.14±0.1528	83.8	11.3	
57	65—B	8.34±0.1155	88.8	14.1	
58	65—C	9.00±0.0071	72.6	15.5	
59	27—B	7.89±0.0721	75.3	17.1	
60	65—D	9.05±0.0897	75.4	14.6	
61	65—D	7.89±0.1502	108.5	12.9	
62	155—B	9.81±0.0982	73.9	18.9	
63	242—A	9.20±0.1790	77.2	16.6	
64	27—D	9.00±0.3702**	95.8	13.7	
65	8—C	7.68±0.2079	82.3	15.6	
66	8—B	8.54±0.1402	76.7	17.0	
67	8—A	7.28±0.1386	89.9	30.6	
68	65—B	7.60±0.3571**	90.2	14.9	
69	155—C	9.30±0.1500	75.7	15.7	
70	27—C	13.34±0.1505	107.2	12.8	結實率只有20.2%
71	8—D	10.37±0.0781	103.7	13.0	
72	27—D	8.15±0.1402	101.1	11.8	
73	242—B	8.83±0.1400	121.8	11.2	
74	8—D	9.11±0.1739	67.1	10.9	
76	65—C	9.73±0.3879	79.8	9.1	
77	65—C	7.99±0.2945	74.2	18.4	
79	65—D	8.95±0.2207	92.2	20.8	
80	65—D	10.63±0.3917	73.1	17.5	
81	155—B	9.12±0.2316	100.2	10.8	

82	155—C	9.33±0.1061	104.9	13.1	
84	27—A	10.55±0.2771	91.1	10.8	
85	27—B	8.62±0.3175	91.4	11.0	
86	27—C	7.97±0.0693	75.6	15.7	
87	27—D	8.86±0.1200	104.9	11.2	
88	27—D	7.12±0.0693	93.9	11.8	
90	8—B	10.40±0.0693	81.7	10.9	
91	8—B	8.42±0.5036	103.1	9.5	
92	8—C	8.62±0.2079	81.0	8.3	
93	8—D	7.89±0.0000	90.5	13.5	
94	242—C	9.87±0.1888	75.9	11.5	
95	242—C	8.97±0.1502	96.8	9.2	
96	242—C	9.81±0.0752	97.5	11.3	
99	242—D	10.83±0.1444	82.2	6.2	
101	北變18×中變75	8.54±0.1502	66.3	13.0	穗重一克以下
102	北變26×北變18	8.42±0.1444	87.1	12.2	穗重一克以下
103	北變26×中變4	9.77±0.000	70.5	14.6	
104	北變26×中變64	10.07±0.1386	74.2	13.6	
105	北變27×中變39	9.22±0.0690	69.9	20.2	
106	北變27×中變64	10.03±0.0693	77.4	14.0	穗重一克以下
107	北變27×中變74	10.59±0.1200	49.3	16.4	
110	中變17×北變18	8.22±0.0693	82.5	11.5	穗重一克以下
111	中變64×北變18	9.14±0.1200	67.3	10.5	
115	北變90×中變146	11.76±0.0000	62.0	17.1	
116	北變90×R_3矮35	9.88±0.0693	70.6	17.0	
117	R_3矮8×嘉南8	9.31±0.0000	77.4	14.8	
118	北變116×中變161	8.82±0.000	73.1	14.1	
119	北變141×北變116	8.86±0.0693	58.2	15.1	
120	中變161×R_3矮51	8.86±0.0693	69.7	11.8	
121	R_3矮6×R_3矮51	10.86±0.1444	70.1	15.2	

〔註1〕 *表2個重複之平均值， **表四個重複之平均值，未打星號者爲3個重複之平均值。

〔註2〕 65—臺中65號　　A—X線20,000r

155—臺中155號　　B—X線25,000r

8—嘉南8號　　C—熱中子15小時

242—嘉農242號　　D—熱中子20小時

27—高雄27號

表二、含蛋白質量最高之五個突變種之一般性狀

突變號	葉色	柱頭色	稃尖色	抽穗期	穗重 (g)	株高 (cm)	有效分蘖	結實率 (%)	突變來源	蛋白質含量 (%)
變 9	P	P	P	6/12	1.58	53.9	8.4	87.2	8—D	11.03
11	P	P	P	5/21	1.46	89.3	9.3	91.4	27—D	11.42
12	P	P	P	5/28	2.06	92.6	9.6	92.3	27—D	11.42
70	G	W	W	6/10	1.34	107.8	12.8	20.2	27—C	13.34
115	G	W	W	6/13	1.98	62.0	17.1	89.8	北變90×中變146	11.76

註：P＝紫色　G＝綠色　W＝白色

四、結　　論

1.本試驗曾利用臺中65號，臺中155號，高雄27號，嘉南 8 號及嘉農242號等 5 個品種經 γ—線及熱中子處理後代分離之107個突變品系為材料，調查其糙米之粗蛋白質含量。107個樣品中蛋白質含量超過10%者18個品系，而其中變9、11、12、70及115五個品系超過11%。變70甚致超過13%。

2.原品種的蛋白質含量係根據林（1962）於一期作所做之調查結果，則臺中65號有8.54%，臺中155號有8.36%，高雄27號有7.48%，嘉南 8 號有8.35%，而嘉農242號有8.10%。糙粒蛋白質含量易受環境影響為周知之事實，但上述五個品系之蛋白質含量比較高，是否屬於遺傳性質，尤其是變70，有必要進一步加以檢討。

3.含蛋白質量超過11%之五個品系中，有三個品系，即變 9、11、12，均有紫色的葉、柱頭、稃尖。除變70外均為矮性之突變體。按變70之含蛋白質量為 13.34%，為本試驗參加品系中最高者，但其結實率只有20.2%。

4.就此等五個品系將來希望進行 albumin、globulins、prolanin 及 oryzenin 等含量，以及各種胺基酸含量之分析，然尋找更多的突變種，繼續做類似此種高蛋白質含量品系之 screening 實有必要。

五、參　考　文　獻

1. A. O. A. C.＝Method of Analysis 10th Edition 1965。
2.李蘭帝：應用擴散法定量氮素之試前檢查　土肥通訊205期，1968。
———大量植物樣本氮磷鉀的迅速測定法　農業研究15卷 2 期，1968
4.林秉湊等：水稻粳米營養調查　農業研究11卷 2 期，1962。
5. Tamura S., T. Suzuki. F Osawa and Y. Tanakaj. High protein rice induced by γ-radiation. The 4th Research Coordinating Meeting on the Use of Induced Mutation in Rice Breed-irg, Tokyo. 1968。
6. Nutritive guality of rice. The IRRI. Annual Report. 1966。

CRUDE PROTEIN CONTENTS OF RICE KERNEL OF VARIOUS MUTANTS INDUCED BY IRRADIATION

by

Pei-Chi Lou, Chen-Seng Huang

SUMMARY

1. One hundred and seven mutants, obtained from the progenies of five leading ponlai (*japonica*) varieties which were treated with γ-rays and thermal neutrons in 1958, were screened for the high content of crude protein in brown rice, as estimated by the total nitrogen content determined by the micro-Kjeldahl diffusion method.

2. The protein contents of 107 mutants varied from 5.45 to 13.34 per cent, while those of original varieties, determined previously ranged between 7.48 and 8.54 per cent (Lin, 1962) , all on dry basis. Five mutants which showed the protein content higher than 11% are mutant No. 9, 11, 12, 70 and 115; that of mutant No. 70 was the highest, 13.34%.

3. All five mutants of which protein contents surpassed 11%, exhibit distinct dwarf stature except mutant No. 70 which is normally tall but has seed fertility as low as 20.2 %. Mutant No.9, 11, 12 have purple leaves, stigmas and apiculi.

不同覆蓋物與施肥量對檸檬草油分之影響

楊 永 裕

緒 言

在本省栽培的精油作物中，香茅草由於歷史久，外銷需量大，種植面積最廣，有關的試驗研究亦較多。據本所近年試種其他精油作物，發現檸檬草亦頗有栽培價值，以其適合本省氣候，生長快速，按五十六年初步試驗估計，於5月同時插植的香茅草和檸檬草，生長1個月後，後者的株高爲前者的1.4倍。鮮草產量爲3.6倍，至3個月，後者株高爲前者的1.3倍，鮮草產量則爲3.6倍，雖然檸檬草的含油率較低，一般約 0.3%左右，然總產油量仍高過香茅草，此外，檸檬草油分品質較高，其主成分檸檬醛（Citral）含量高，用途廣泛。

檸檬草在本省的栽培試驗，尚未見有試驗報告。 Miyazaki (1958) 報告，在日本盆栽檸檬草，施用三要素肥料的試驗結果，發現（1）在肥料中不加氮肥的處理（PK區）油分中 Citral 含量略趨向增加，而不施磷肥或鉀肥的影響甚微（2）鮮草含油百分率受肥料處理的影響很小，本試驗的目的在於研究不同覆蓋物對檸檬草的含油率及油分中 Citral （含量的影響，以及此項覆蓋作用，受施肥量的影響如何。玆將初步結果撰爲報告，以供農界人士參考。

試驗材料及方法

檸檬草（Cymbopogon citratus）爲自印尼引進，係多年生草本，可用根莖分株繁殖，供試材料係取自本所精油植物保存圃。採用3×4複因子完全逢機設計，5重覆，處理分十二種，由三種施肥量（F_0不施肥，F_1少量肥 N 100kg/ha P及 K皆 50kg/ha F_2 多量肥，爲少量肥之一倍）和四種覆蓋物（（M_0 不覆蓋 M_1 覆以蒸餾後殘草， M_2 覆蓋透明塑膠布 M_3： 覆蓋不透明之乳白色塑膠布）組成，每一處理兩盆，各植一株，檸檬草於5月中插植，7月6日刈齊，隨即開始施肥及覆蓋，9月6日收刈，鮮草收刈後秤重，風乾兩日，再以小型油分定量器，蒸餾半小時，所得油取4—6 ul. 以氣相色析儀（Gas chromatography）定量油分中 Citral 含量。

試 驗 結 果

鮮草產量及收油量——鮮草產量（表一）隨施肥量而明顯增加，但只有施多量肥較不施肥的增產達到統計上的顯著水準，各種覆蓋處理中，覆以塑膠布的處理，產草量皆較低，雖與不覆蓋處理之差異不顯著，較之覆草處理則顯著爲低，其原因主爲塑膠布覆蓋太密使雨水或灌水均不易進入土壤，致植株缺水，生長較差，結果遂以覆草處理的鮮草產量最高。

收油量受鮮草產量及含油率之影響，由表一可見，覆蓋均有促進含油率之效果，其中覆草作用較小，透明塑膠布可提高含油率0.06%而以乳白塑膠布效果最大，含油率較不覆蓋高出0.13%，較覆草亦高出0.12%，因此塑膠布處理的鮮草產量，本係顯著低於覆草處理，因其含油率高，結果收油量並不低於覆草處理，尤以乳白塑膠布覆蓋者，其收油量更高出一成，惟其差異在統計上則不顯著。

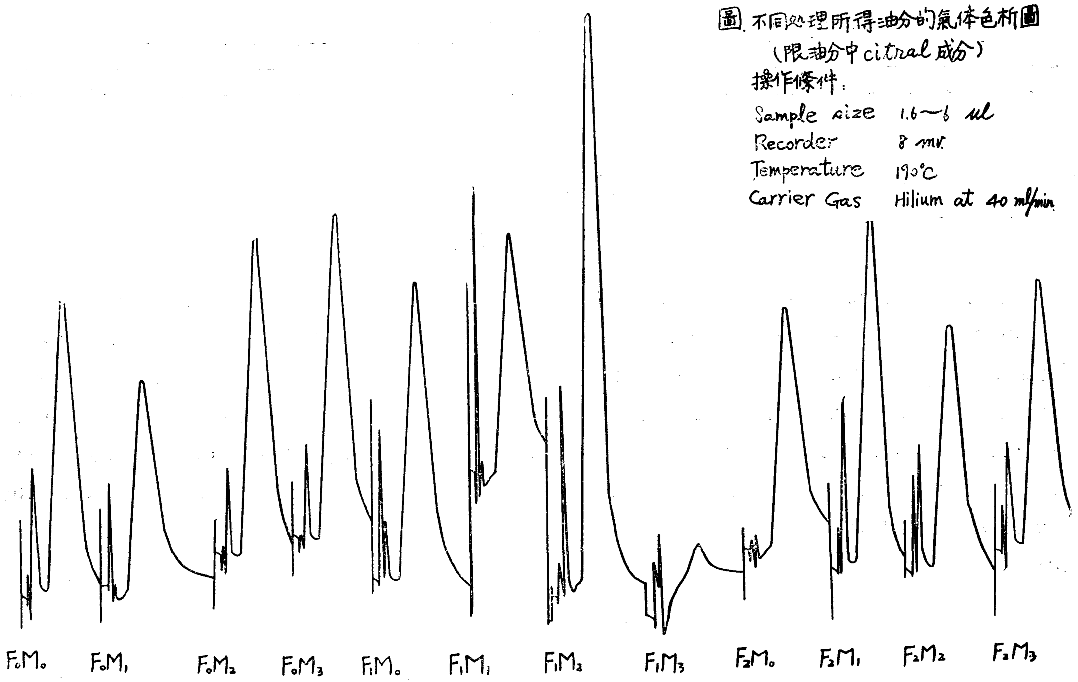
同樣施肥量因對含油率若有降低影響，故雖施肥可顯著提高產草量，以含油率降低，結果收油量在施肥量處理間差異不顯著，然由表一可發現，施肥收油量仍較高，此表未施肥對鮮草的增加作用大，而對含油率的降低作用小。

油分 Citral 含量——油分中 Citral 含量所受覆蓋及施肥之影響爲本試驗主要目的。但以試驗材

料少，收油量不多，以致無法以本研究室現有設備加以定量，7月蒸溜所得油分，延至次年5月，始藉氣相色折儀（Gas Chromatography）定量，由於油分放置時間過長，同時密封不善，導致精油中各揮發成分之損失，結果 120個樣品，大部份成半固體或粒稠狀油，只有第三重覆尚稱完整，根據第三重複的分析結果（表一）覆蓋均可提高 Citral含量，而以乳白色塑膠布處理的含量最高，較不覆蓋高13%，較其他種覆蓋亦高出3—4%，覆草和覆蓋透明膠布間的差異很小，兩者均較不覆蓋處理增加8.7～9.4%在施肥方面，少量肥似對 Citral 含量無大影響，只較不施肥區低0.8%，但施多量肥則使含量降低4.2%。

表一　不同覆蓋物與施肥量對鮮草產量、收油量、含油率及檸檬醛含量之影響

施肥量	覆蓋物				平均
	M_0	M_1	M_2	M_3	
		鮮草產量 gm			
F_0	260	270	238	246	255b
F_1	292	316	276	263	287ab
F_2	316	426	324	254	330a
平均	289ab	340b	279a	255a	
		收油量 gm			
F_0	1.13	0.87	0.89	1.17	1.01a
F_1	0.90	1.14	1.15	1.10	1.07a
F_2	0.86	1.22	1.12	1.29	1.12a
平均	0.96a	1.07a	1.05a	1.18a	
		含油率 lot/col%			
F_0	0.43	0.32	0.37	0.47	0.39
F_1	0.30	0.36	0.41	0.41	0.38
F_2	0.27	0.28	0.34	0.50	0.35
平均	0.33	0.34	0.39	0.46	
		檸檬醛含量%			
F_0	79	72.8	90.4	92.2	83.6
F_1	81	70.0	91.4	—	82.8
F_2	67.4	94.4	71.9	84.5	79.4
平均	75.8	85.2	84.5	88.3	



討　　論

一般欲提高作物產量，施肥殆爲最有效之方法，但施肥固可增加產量，對品質則往往有相反影響，在產量與品質不可得兼情形下，惟有捨品質而取產量，因品質所受影響，通常均較小，然此終非上策，欲解除此一困難，必須尋求增產而不影響品質之措施。

作者前曾報導，香茅園覆草處理，在不施肥下，有顯著提高香茅醛含量之效果（1966）此一結果似可在施肥影響品質方面，提供解決途徑之一，本試驗結果，可云爲又一佐證，在此，施肥尤其爲多量肥，對產草量固有顯著增加效果，對油分主要品質 Citral 含量，却有降低作用，而 Citral 含量之降低，則可藉覆蓋，尤其是乳白塑膠布以恢復之，故施肥輔以適當覆蓋材料，即可維持油分品質。

本試驗由於大部份樣品油變質，致此一結論無法獲得充分支持，相信進一步深入的研究，當可得到更多證據。

摘　　要

爲測定覆蓋與施肥量對檸檬草含油率及油分中 Citral 含量的影響，特以盆栽的檸檬草，施以由三種施肥量和四種覆蓋物組成的十二種處理，試驗結果指出施用三要素肥料，對降低含油率的影響不大，而對增加鮮草產草則有顯著效果，對於油分中 Citral 含量，施多量肥有明顯的降低作用，但此種不良影響，似可藉覆蓋、尤其覆以乳白色塑膠布予以補救，此外，乳白色塑膠布並可提高含油率，比不覆蓋高0.13%。

參 考 文 獻

1. 楊永裕（1966）香茅草栽培法改良試驗農業研究。Vol 15 No.4 P23—40

2. 楊永裕、陸之琳（1967）香茅草栽植距離試驗農業研究Vol 16 No.1 P42—49

3. 楊永裕（1968）香茅草的肥料試驗中國園藝 Vol 14 No. 1,2 P1—6

4. Miyazaki Y (1958) The effects of fertilizer elements on the growth and oil and citral contents of Lemon—grass Jap J Trop Agric Vol 2 No. 1

INFLUENCE OF MULCHING MATERIALS AND FERTILIZER LEVELS ON THE OIL OF LEMON GRASS

By

Y. Y. YANG

ENGLISH SUMMARY

In order to investigate the effect of mulch and fereilization on oil and citral content in Lemon grass, a complete rendomized pot experiment was conducted with replications. Four different mulch materials were combined with three levels of fertilizer to form twelve treatments. The result showed that oil content had only a little response to fertilizer application but tended to be increased by mulch of with wnite polystylene. High fertilizer level depressed greatlv the citral content in oil But this advice effect was improved by mulching treatment. The higest citral content was also obtained from the treatment with white polystylene.

HISTOGENIC DEMARCATION IN DISEASED PLANT

by

C. C. Tu

Introduction

Defensive reactions are known as vital processes initiated in a host plant by a pathogenic agent and directed more or less specifically against that agent itself. Gäumann (5) has classified defensive reactions in plants into three groups based on the object of reaction and into six kinds as to the type of reaction (Table 1).

Table 1. Types of defensive reactions in plants (5)

Object of the reaction	Historical development	Type of reaction
The pathogen itself (anti-infectional reactions)	Autonomous	1. Plasmatic anti-infectional reactions
		2. Necrotic reactions
	Induced	3. Premunity
The metabolic products of the pathogen (anti-toxic reaction)	Autonomous	4. Histogenic demarcations
		5. Gummous demarcations
The innate Sensitiveness of the host (induced tolerance)	Induced	6. Desensibilization

The histogenic demarcation is a defensive reaction in which the host protects itself against toxic metabolic products emanating from the pathogen and from its own necrotic cells (5).

Many necrogenic fungi parasitic upon the leaves of plants make only limited growth, which results in definite lesions. The reason for such limitations of growth are purely physiological in character and have to do with the biochemical relation of pathogen and suscept (3).

Histogenic demarcations occur in the shot-hole disease of plums, peaches, and cherries (4), and in varieties of tobacco resistant to black root rot (2). In some woody plants, the demarcation tissues are not shed after they dam up the toxic substance (6).

The Cicatrice Formation and Histologic Changes in Plants.

There are numerous references in literaure to the healing of wounds by the histological changes resulting in callus formation in woody stem and cicatrice formation in leaf. Upon the death and collapse of exposed cells along the edges of wounds, a temperary protection is developed and is called a pseudocicatrice. Beneath this covering, the living parts slowly give rise to new layers of cells, which in time mature into the true cicatrice. This structure

varies greatly, but in thicker leaves may be a compact cork-like tissue with heavily suberized and highly modified cell walls(11). This cork-like tissue is largely formed by the development of new cells resulting from mitoses (10). Mitoses rarely occur within 24 hours after wounding. In thin mesophytic leaves, the cicatrice is complete in about 10 days, whereas in thick and xerophytic forms, up to 20 days might be required for its completion (11).

Blackman and Matthaei (1) removed leaves of *Prunus laurocerasus var. rotundifolia* and placed the petioles in a beaker of water. No healing tissue was formed when these leaves were wounded. If a sufficient number of cells were killed about the edge of the wound, however, an abscission layer was formed. The wounded portion eventually dropped out and the walls of the callus cells became cuticularized. Leaves wounded while stile attached to the plants formed an abscission layer very quickly. The wounded portion did not fall out, but division of the newly formed cells continued until a periderm of several layers of cork resulted (1).

Cunningham (3), in studies of some species of *Prunus*, *Pyrus communis*, and *Beta vulgaris*, also found that the natural reaction of the suscept to injury is the formation of a cicatrice. That the formation of a cicatrice is a common accurrence in the leaves of many higher plants is evident from the work of Wylie (10,11), Blackman and Matthaei (1), Cunningham (3), and others.

The Histogenic Demarcation Reaction in Diseased Plants

There are comparatively few reports in the literature about the reaction of plants to invasion by necrogenic pathogens. In 1892, Pierce (8) stated the shot-hole lesion in lesves of almond caused by *Cercospora circuncissa* is bounded by plesionecrotic and thickened tissues (8).Working with *Coccomyces sp.* in *Prunus*, Higgins (7) found that there was considerable variation in the same species. He states that the separation of tissues is due to the abrupt enlargement of a layer of cells at some distance from the ends of the mycelium. The enlarged cells lose their chloroplasts and nuclei, and only a thin layer of protoplasm lines the walls (7). Cunningham (3) stated that the cicatrice formed at the edge of necrotic pathological lesions is similar in its general characters to that formed as a natural reaction of the suscept to mechanical injury.

There is also variation with the position of the initial infection; different types of histogenic demarcation tissue formed in different parts of plants after infection by different pathogenic organisms.

Demarcations in leaves:

Samuel (1927) states if the leaves of *Prunus spp.* are infected by the conidia of *Clasterosporium carpophilum*, the causal agent of shot-hole disease ,the germ tube penetrate either through the epidermis or through the stomates. Once inside, the fungus proliferates in all directions in and between the cells. Within 38 hours after infection, the cells entered by the pathogen are seriously injured and about to collapse. Their walls are thickened and brown. As a consequence of the distant action by toxins, the nearest hypodermal cell, although not directly attacked, shows a brown discoloration (hyperergic effect). Moreover,

in neighboring cells, the chloroplasts have disappeared and, still farther away, they have shrunk and become light green.In the spongy mesophyll, no changes are yet apparent except for a dark coloring of two cells (again the result of action at a distance). Fifty-six hours after infection the lesion is already 1-2 mm wide and, therefore, visible macroscopically. The mycelium has invaded the spongy tissues and the neighboring vascular bundles, in which it has obliterated the phloem parenchyma. A few epidermal cells are brown and collapsed. The hypodermis is disorganized and collapsed. The infection spot then appears on the leaf surface as a small pit. Numerous cells of the spongy mesophyll are in the process of degeneration, and the toxins of the parasite are causing disintegration of the chloroplasts right up to the palisade tissues. After 4 days, the hyphae have reached the palisade tissues. Macroscopically, the necrotic cells in the center of the lesion are seen as a brown patch, surrounded by a lighter green zone (the cells containing the disorganized chloroplasts.).

Histogenic defense reactions set in between the fourth and eighth days. At a distance of about 20 cells from the brown necrotic zone, a narrow band of cells which involves all the leaf tissues begins to swell slightly; the cells are squeezed closely so that the intercellular spaces disappear, as do the chloroplasts; the protoplasm becomes denser, the nuclei increase slightly in size, and the cells assume a maristematic character. As a consequence of the disease, tissues which had already matured have again become capable of undergoing division. Vigorous cell division also sets in throughout the vascular bundles, whose parenchyma cells have been rejuvenated, and the xylem elements are squeezed to the periphery of the bundle. On the one hand, this abscission tissue interrupts the supply of nutrients from the healthy tissues to the lesion so that this gradually shrivels.

In young leaves, begining at the lower epidermis, the middle lamellae in a certain zone began to disintegrate, usually in such a way that one cell row accrues to the focus, while the three and four others remain part of the healthy leaf. In this way the focus of infection becomes spatially cut off from the healthy tissues and subsequently is actively thrust away from the lower side of the leaf.

Scarring now begins along the edge of the wound by the initiation of a wound periderm, A middle cell row, the phellogen, forms on its outer side two or three slowly lignifying and then suberizing of phellem cells and, on the inside, three or four rows of only cellulose thickened phelloderm. With this, the histogenic demarcation is completed (6,9).

Cunningham (1928) studied on the histological changes induced in leaves by certain leaf-spoting fungi and showed that species of *Prunus*, *Pyrus*, and *Beta* may be expected to react, when attacked by nectogenic pathogenes, by the formation of a cicatrice which isolates the infected portion from the healthy tissues. The character of this cicatrice and the extent of healing tissue differs with the relation of the infected portion to veins and islet borders (3).

The character of the cicatrice is essentially the same in all plants, The most striking features of this structure are the renewal of the meristomatic condition in the mature mesophyll cells. This results in a multiplication of cells in this region, the occlusion of intercellular spaces, and the formation of a definite wound periderm with its phellogen layer. Cork cells produced by the phellogen are frequently greatly enlarged (3).

Demarcations in roots and branches:

Demarcation reactions in branches and roots is sometimes accompanied by an expulsive or scaling reaction (6). Conant (1927) studied the root rot of tobacco caused by *Thielavia basicola*, and stated that the rapidity with which a tobacco plant can initiate and continue cork formation beneath a lesion is an accurate criterion of its resistance to *Thielavia*. Different degrees of histogenic demarcation reactions occur among different varieties of tobacco. In strongly resistant strains of tobacco, or in strains made resistant by exposure to high temperatures, the host tissue several layers of cells deeper than those actually invaded are stimulated to active cell division, forming a phellogen which further limits the progress of the fungus by proliferating cork cells toward the point of invasion. In other varieties of tobacco, however, the reaction occurs first in that part of the pericycle which lies immediately beneath the lesion. In the semi-resistant varieties, the histogenic demarcation fails to keep the fungus out of the stele in all cases, especially where the attack is made by a large waft of hyphae (2,6).

The Characteristics of Histogenic Demarcation in Diseased Plant.

The evidence presented above shows that there are histogenic demarcations formed in plants after penetration by pathogens. There are also two important characteristics of such kinds of defensive reaction in diseased plant: it is either an anti-toxic reaction or an autonomous reaction.

Anti-toxic reactions:

Duggar (4) first drew attention to the fact that the shot-hole effect on leaves of species of *Prunus* was produced not only by a number of fungi, but also by spraying with injurious solutions such as copper sulphate, formalin, corrosive sublimate, and others. McWhorter (3) has shown that this layer (cicatrice) may be penetrated to a slight extent by *Cladosporium papaya*. In the case of shot-hole disease in stone fruit tree (*Prunus spp.*) caused by *Clasterosporium carmophilum*. Gäumann states that the shot hole effect is not directed against the invading parasite but against its toxins and the host's own necrogenous products (6). The parasite causes the necrosis, giving rise to necrogenous substances. These, in the usual way, stimulate the formation of wound periderm.

Gloeosporium fructigenum (Bitter rot), possess fully developed antigenic properties but they develop more rapidly than the demarcation reac tion can follow, so that this lags behind; the race between pathogen and host is here won by the pathogen (7). The result is that the parasite successively colonizes the whole leaf.

So far as histogenic demarcation posses chiefly anti-toxic, not anti-infectional properties; therefore the parasite is sometimes able to penetrate them(5).

Autonomous reactions:

It is natural for plants to form a healing tissue around the wound and thereby recover from injuries. In some plants, wounds are healed simply by drying of the wound surface, whereas some form a special tissue such as cicatrice along the wounded edge (11). These are autonomous reactions of the plant itself.

Conclusion

The chain of reactions in histogenic demarcations is not initiated by the parasite itself, but by the necrosis caused by it. To this extent, demarcation reaction is non-specific, being indifferent to the particular source of the necrosis of the lesions, toxins of the parasite, or any other organic or inorganic poisons (5,6).

The defensive reactions classified by Gäumann include three groups and six different kinds. Here, histogenic demarcations are one kind of protection which is effected by means of the antitoxic reactions; their aim is not to prevent infecton, but to prevent disease.

Literature Cited

1. Blackman,F. F., and G.L.C. Matthaei. 1901. On the reaction of leaves to traumatic stimulation. Ann. Bot. 15:533-546.
2. Connat, G.H. 1927. Histological studies of resistance in tobacco in *Thielavia basicola*. Amer. Jour. Bot. 14:457-480.
3. Cunningham, H.S. 1928. A study of the histologic changes induced in leaves by certain leaf-spotting fungi. Phytopathology 58:717-751.
4. Duggar, B.M. 1898. The shot-hole effect on the foliage of the genus *Prunus*. Proc. 19th meeting Amer. Soc. Prom. Agr. Sci.
5. Gäumann, E. 1946. Types of defensive reactions in plants. Phytopathology 36:624-633.
6. Gäumann, E, 1950. Principles of plant infection. London, Crosby Co.
7. Higgins, B.B. 1914. Contribution to the life history and physiology of *Cylindrosporium* on stone fruits. Amer. Jour. Bot. 1:145-173.
8. Pierce, N.B. 1892. A disease of almond trees (Cercospora circumcissa Sacc.).Jour. Mycol. 7:66-77.
9. Samuel, G. 1927. On the shot-hole disease caused by *Clasterosporium carpophilum* and on the 'shot-hole' effect. Ann. Bot. 41:375-404.
10. Wylie, R.B. 1922. Some wound responses of foliage leaves. Proc. Iowa Acad. Sci. 29:238-244.
11. Wylie, R. B .1927. Leaf structure and wound response. Science 65:47-50.

罹病植物之組織隔離反應

杜　金　池

植物對疾病之防禦反應一向被認爲是因爲病原體在植物體內之進展而引起之對該病原菌本身之一種或多或少具有特殊性之抗禦作用。Gäumann 曾將植物之防禦反應，據防禦對象分成 3 種，另按防禦反應之類型分成 6 種。本文論述之組織隔離反應（Histogenic demarcation reaction）即爲該氏依據反應類型而分類之一種。

組織隔離反應是寄主植物因抵制從病原菌或植物腐爛細胞所產生之異化物質而產生的保護植物自身的一種防禦反應，所以與其他類型之植物防禦反應不能混爲一談。

梨、桃等許多植物之穿孔病爲植物組織隔離反應的典型例子。這種防禦反應不僅可發生在葉片，亦可發生在根、莖等部位。然而因發生部位之不同而反應過程及結果亦稍有差異。以 *Clasterosporium carpophilum* 引起之櫻桃穿孔病爲例，當葉片被病原菌侵染後 4 至 8 日間，組織防禦反應即始發生。距離被侵染之腐敗斑點約20個細胞處的健全細胞，圍成一狹帶，並稍膨脹，這些細胞互相擠集，細胞間隙及葉綠體消失，原生質濃縮，細胞核增大，而具活性。當病情擴展時，在病斑四週的已成熟之細胞再次恢復分裂，此極活潑之細胞分裂，透過維管束，而將導管擠在週緣，另方面這些隔阻組織，中止營養分從健全組織進入病斑內，終使腐敗之罹病斑點脫落。

罹病植物之組織隔離反應具有兩大特性，是抗毒質反應，亦是植物體之自動反應。因爲這種組織隔離反應是緣賴病原菌引起腐爛而導致，並非病原菌自身所引起，所以這種組織隔離反應並無特殊性，不論何種腐爛病斑內之物質，寄生菌產生之毒質，或是有機或無機物所發生之結果均無差異性。

基於上述原因，植物組織隔離反應乃是植物抗禦有毒物質而產生之保護自身健康之反應，其目的不在防止病原體（菌）之侵染，而在於防止疾病之擴展。

大豆細菌性斑點病之研究

朱 啓 魯　　陳 建 忠

一、前　　言

大豆細菌性斑點病（Bacterial Blight）在臺灣僅見有文獻之記載而缺乏系統性之研究，因而就發生病學及生態學方面探討本病害之特性以作鑑定之根據。

本病害常發生於濕冷之季節而普遍侵害葉部，但有時也侵及莖部及豆莢，在新竹、苗栗及屏東一帶之大豆田中可發現此病。葉部發病時形成小而多角形之黃色斑點且其中心處呈水浸狀，其四週由狹窄而黃綠色之暈環所圍繞，嚴重時病斑變褐或變黑甚而小型病斑癒合而成不規則之塊狀病斑，有時病菌也可沿葉脈侵入。

引起本病害之病原細菌爲 *Pseudomonas glycinea* Coerper 具有綠色螢光，本病之傳播係種子着生（Seed borne）感染，同時也可經病葉而感染，爲大豆最嚴重之細菌病，被害嚴重時，引起早期落葉，影響大豆生育甚爲顯著。本研究承農復會補助並蒙蘇鴻基博士之指導，特此謹致謝忱。

二、材 料 與 方 法

（一）試驗材料：

1. 大豆品種：(1)臺大高雄五號(2)臺農二號(3)三國(4)64—91。
2. 病原菌 *Pseudomonas glycinea* Coerper（自苗栗農校農場田分離）。
3. 枯草菌 *Bacillus subtilis*（取自中興大學）。
4. 大腸菌 *Escherichia coli*（取自中興大學）。
5. 金剛砂：（600mesh）

（二）試驗方法：

1. 接種：

於溫室盆栽大豆品種爲臺大高雄五號、臺農二號、三國及 64—91 等四品種，俟其植株長達 20～25cm 時施以人工接種，其法爲先用脫脂棉沾以75%之酒精消毒健全之葉面，蒸餾水冲洗之，待其乾燥後再以金剛砂輕微擦傷葉片並以無菌水冲去金剛砂，然後將病原菌懸浮液噴佈或塗於葉片，置接種室中保持適當溫濕度，經 24 小時移出，待一定期間後觀察其發病反應。

2. 病菌形態之觀察：

菌體用陰染色法染色以油鏡頭鏡檢並用測微計測其大小。

3. 染色性：

利用單染色法，Gram 氏染色法，抗酸性染色法及鞭毛染色法以觀察病原菌之染色性質，並用枯草菌及大腸菌作對照。

4. 培養性質：

用斜面培養，穿刺培養及液體培養等方法觀察菌體之發育生長狀況。本試驗進行時固體培養基採用pH7.0之 Medium B（Proteose peptone 20 gm, Glycerol 15gm, K_2 HPO_4 1.5 gm, $MgSO_4$ $7H_2O$ 3gm, Agar 15gm per liter of H_2O）液體培養基爲 Nutrient Broth（Beef extract 3 gm, Peptone 5 gm, Nacl 5gm, Agar 18gm per liter of H_2O）

5. 生理性質：

利用化學或物理的方法以測定本病原菌之各種生理性質反應並用枯草菌及大腸菌爲對照，記

錄其反應以作鑑定之依據。

三、試驗結果

1.接種：

於24.5°C溫度下，經接種後之葉片4—5天即出現黃褐色之斑點，嚴重時則病斑癒合而爲大型之黑色病斑，若於葉片背面接種則較葉片表面易於發病，有時病菌也可沿葉脈蔓延，較罹病之品種爲64—91，臺農二號，較抗病者爲臺大高雄五號及三國。

2.病菌形態：

病原菌用陰染色法（Negative staining）鏡檢結果，在陰染之背影中呈現短桿狀近橢圓形之桿狀菌，由所測52個菌體之平均爲2.402×2.065μ。

3.染色性質

細菌施以Gram氏染色法，抗酸性染色法及鞭毛染色法觀察其反應結果如表一。

表一：菌體之染色反應

染色種類 ＼ 菌類別		*Pseudomonas glycinea* Coerper	*Bacillus subtilis*	*Escherichia coli*
The gram stain	呈色	紅	濃 紫	紅
	反應	−	+	−
The acid fast stain	呈色	藍	藍	藍
	反應	−	−	−
Flagella staining		單極鞭毛	周鞭毛	周鞭毛

「註」：（十）表示陽性反應（一）表示陰性反應

4.培養性質：

固體培養時，置 28°C 之定溫箱中經48小時以觀察平面及斜面之培養性質，穿刺培養時經六天，液體培養時，置 37°C 定溫箱中經48小時，其結果如表二。

表二：菌體之培養性質

培養方法 ＼ 菌類別		*P.glycinea* Coerper	*B. subtilis*	*E. coli*
平面培養（菌落）	形狀	點狀（Point form）	鈍形	不規則
	高度	穹隆狀（Pulvinate）	穹隆狀	穹隆狀
	周緣	全緣	粗糙	全緣
斜面培養（劃線）	形狀	小棘狀（Echinulate）	小棘狀	小棘狀
	呈色	具綠色螢光	乳白色	白色
液體培養（表面生長情況）(Nutrient broth)		環狀（Ring）	表皮狀（Pellicle）	膜狀（Membranous）

5.生理性質：

菌類之生理性質係種類鑑定上重要之一環，茲將有關之重要生理反應 述之於後：

白明膠之液化　利用白明膠培養基培養結果 *P. glycinea*及*E. coli* 不能使白明膠液化而枯草菌則具有使白明膠液化之能力。

吲哚之反應：經 Kovacs及Gnezda 法測定結果*P. glycinea*及*B.subtilis* 都不能產生吲哚而*E. coli* 則有吲哚之生成。

表三　細菌硫化氫之生成及 Gram 氏染色反應

反應 ＼ 細菌別		*P. glycinea*	*B. subtilis*	*E. coli*
Iron Agar	性狀	有	有	沒有
	强度	+++	++++	−
Lead acetate Agar	性狀	有	有	沒有
	强度	+++	+++	−
Gram反應	Iron Agar	−	+	−
	Lead acetate Agar	−	+	−

表四：細菌氨之生成

檢驗法 ＼ 細菌別		*P. glycinea*	*B. subtilis*	*E. coli*
Nessler 法	呈色	橙黃色	橙黃色	淺橙黃色
	强度	++	++	+
石蕊試紙法	呈色	藍色	藍色	藍色
	强度	+++	+++	++

表五：以硫磺酸試液與α-naphthylamine測定細菌之硝酸鹽還原作用

培養日數及反應 \ 細菌別		P. glycinea	B. subtilis	E. coli
二日	呈色	淡紅色	淡紅色	紅色
	强度	+	+	++
四日	呈色	血紅色	橙紅色	暗紅色
	强度	+++	++	+++
六日	呈色	暗紅色	暗紅色	暗紅色
	强度	++++	+++	+++
八日	呈色	淡紅色	深橙紅	淡紅色
	强度	++	++	++
十日	呈色	深橙黃色	橙黃色	橙黃色
	强度	+	+	+

表六：細菌於 Litmus milk培養液中對牛乳之消化能力及醱酵

細菌別	反應性	凝乳		消化
		Acid	肉膜形成	
P. glycinea	−	藍色	没有	−
B. subtilis	+	棕色	有	+
E. coli	+	紅棕色	没有	−

表七：細菌之澱粉水解作用

細菌別	培養法呈色		過濾法呈色	
	呈色	強度	呈色	強度
P. glycinea	藍色	++	藍色	++
B. subtilis	紅褐色	+	紅褐色	+
E. coli	藍色	++	藍色	++

表八：細菌對碳水化合物之醱酵作用

碳水化物及反應 \ 細菌別		*P. glycinea*	*B. subtilis*	*E. coli*
Glucose	氣體之生成	−	−	+
	酸性反應	+	+	+
Lactose	氣體之生成	−	−	+
	酸性反應	−	−	+
Sucrore	氣體之生成	−	−	+
	酸性反應	−	−	+

表九：700mμ（光譜） 下pH值對*P. glycinea* 之生育影響

pH值	混濁度	pH值	混濁度
2.8	0.01	6.8	0.33
3.6	0.03	7.6	0.29
4.4	0.30	8.4	0.19
5.2	0.46	9.2	0.12
6.0	0.42	10·0	0

表十：溫度與 *P. glycinea* 生長之關係（培養二十四小時）

溫　　度	冰箱 5°C	室溫 21°C	25°C	28°C	30°C	35°C	40°C
生長狀況	−	+++	+++	++++	++++	+++	−

由以上結果顯示大豆細菌性斑點病(*Pseudomonas glycinea* Coerper)病原菌具綠色之螢光，菌落圓形，邊緣光滑，液體培養時表面呈環狀。菌體呈短桿狀近橢圓形，Gram氏陰性菌，非抗酸性反應，單極鞭毛菌。本病菌不能形成吲哚，可產生氨及硫化氫，能使硝酸鹽還原，對白明膠無液化之能力，對牛乳無消化或醱酵之能力，不能使澱粉水解，對 glucose可產生酸但無氣體之產生，不能使Lactose產生酸或氣體，pH值之發育範圍爲pH4.4～7.6最適溫度 28～30°C 最低溫度爲 5°C最高溫度爲 40°C

四、結　　論

本病害於大豆春作時發病較重而於夏作時則發病甚少，此因春作時氣溫低濕度大，每使豆苗生長勢不佳，致枝葉有遲滯之現象而極易感染大豆細菌性斑點病，氣溫高而又乾燥之夏作期中，一般豆苗均生長良好，不易感染病害且也不宜於病菌之發育。病菌多侵害葉部，有時也侵及莖部及豆莢。

引發本病之病原菌爲 *Pseudomonas glycinea* Coerper 在其培養物上可看到綠色之螢光，鏡檢時菌體短桿狀近橢圓形，在消毒之馬鈴薯塊上培養呈黃棕色，生長旺盛而無腐蝕性，能使硝酸鹽還原，對澱粉無水解作用，能使葡萄糖（glucose） 醱酵而產生酸但不產生氣體，此種特性可供作簡單之鑑定方法。

五、摘　　要

1.本病害常發生於濕冷之季節而普遍侵害葉部。
2.引起本病之病原菌爲*Pseudomonas glycinea* Coerper係種子着生菌，也可經由病葉感染，培養基斜面培養時，呈現綠色之螢光。
3.病原菌呈短桿狀、 Gram陰性菌、非抗酸性、單極鞭毛。
4.平面培養時，菌落圓形，邊緣光滑，斜面培養時，菌體呈小棘狀、液體培養基培養時，表面呈環狀。
5.病原菌發育之最適溫度爲 28～30°C最低溫度爲 5°C最高溫度 40°C。
6.病原菌發育之適當 pH值爲 pH 6.0～7.4。
7.大豆品種三國及臺大高雄五號較爲抗病，臺農二號及64—91則較爲罹病。

六、參 考 文 獻

1. Donald Champerlain and Benjamin Koehler. 1964. Soybean Diseases in Illinois. Circular 676, pp. 16–17.
2. Cross, J.E. et al. 1966. Plant Disease Reporter. 50(8):557–564.
3. Howard w. Johnson el al. 1954. Diseases of Soybeans and Methods of Control Circular No. 391, pp. 2–4.
4. Howard w. Johnson el al. 1955 Soybean Diseases. Farmer's Bull. No 2077. pp. 3–5.
5. Lo. T. T. 1961. A Brief Report on the Plant Diseases and their Control in Taiwan. p17.

6. Pelcizar, M. J. 1957. Manual of .Microbiological Method. pp. 140–166.
7. Robert, S. Breed et al. 1957. Bergey's Manual of Determinative Bacteriology. 7th Edition. pp. 3–5.

STUDY ON BACTERIAL BLIGHT OF SOYBEAN CAUSED BY *PSEUDOMONAS GLYCINEA* COERPER

By

C. L. Chu and C. C. Chen

SUMMARY

This report deals with one of the most important bacterial disease of soybean caused by *Pseudomonas glycinea* Coerper. The results obtained are summarized as follows.

1. Bacterial blight of soybean is more serious during periods of cool weather and fre quent rains especially in spring season of cultivated soybean field.

2. The disease is caused by *Pseudomonas glycinea* Coerper which are seed-borne and can survive also in diseased leaves from growing season to the next.

3. The pathogen is short rod in shape and showed reactions of Gram negative, non-acid fast stain, single flagellum.

4. The culture of the organism shaped circular, echinulate and ring forms in agar colo ny, agar stroke and nutrient broth respectively.

5. The optimum temperature of the pathogen are 28°–30°C, minmum 5°C, maximum 40°C.

6. The optimum pH value for the development of the pathogen are between 6.0–7.4.

7. Varieties of Sanko and TuKH No. 5 are less suceptible than Tainung No. 2 and 64–91.

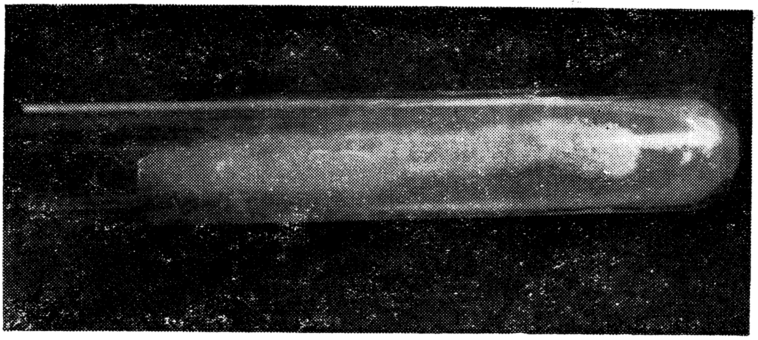


Fig. 1: *Pseudomonas glycinea* Coerper

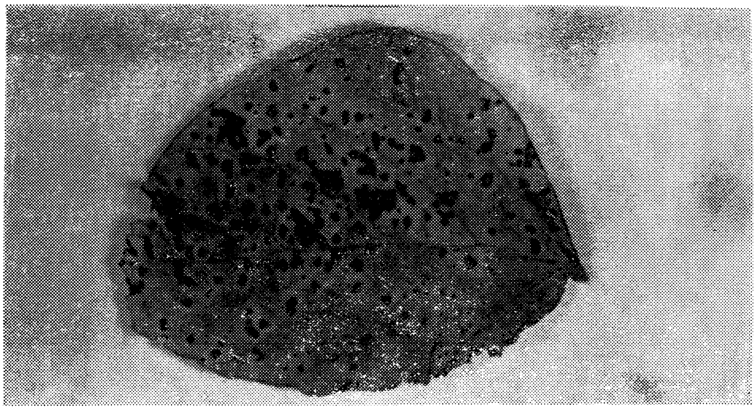


Fig 2: Bacterial blight on the upper surface of a soybean leaflet

Fig 3: Bacterial blight on the lower surface.

洋菇腦菌病病原菌生理研究（第二報）

杜自彊　于紫靜

一、前　言

洋菇腦菌病是洋菇栽培上之嚴重病害，爲求徹底之防治方法，除由藥劑方面直接殺菌外，由其病原菌之生理研究利用洋菇栽培技術之改進，在不影響洋菇正常生長之原則下，減少腦菌病之發生更爲經濟而理想之方法，本病1929年在美國 Ohio 州發現，後經 E.B.Lambert 氏（3）研究定名，學名爲 *Pseudobalsamia microspora* Diehl and Lambert, 1954年 Gilkey 氏（5）建議改爲*Diehliomyces microsporus*，英文病名稱 Calve's Brains 或 Truffle Disease 屬於子囊菌類，本病於1963年在本省發現，1964年始有記載（15），近年來本病嚴重影響洋菇產量甚鉅。本報告係由農復會56/57-MRF-PP-22 計劃補助完成，茲將試驗結果整理如下：

二、材料及方法

1.腦菌病病原菌對氨態氮之生理利用試驗：

與本所試驗報告第25號洋菇腦菌病病原菌生理研究之第四項同（14）。

2.腦菌病病原菌對滲透壓之抗性試驗：

無菌水調製不同克當量濃度之鹽類硫氨 $(NH_4)_2SO_4$ 及食鹽（Nacl）以腦菌病之病原菌子囊果經不同時間之浸漬後，取出以無菌水洗滌移於堆肥洋菜培養基試管中斜面培養，在 28°C 定溫箱中培養二星期後，觀察其生長。

3.洋菇病原菌之致死溫度試驗：

病原菌：*Diehliomyces microsporus*
Trichoderma koningi
Thielavia terricola
Fusarium sp.
Penicillium spp.
Chaetomium sp
Cephaliophora sp.
Myriococcum sp.
Helminthospora sp.
Sphaerotheca sp.
Mucor sp.

上述11種病原菌已培養於試管中長滿菌絲者，置於 60°C 定溫箱及恆溫水槽中（保持 60°C），以不同時間處理後，移於堆肥洋菜培養基斜面培養，於 28°C 定溫箱中培養一星期後，觀察其成活及死亡情形。濕熱處理者，以無菌水灌注於供試之試管中後，置於 60°C 之恆溫水槽，另以無菌水灌注者，置於 28°C 定溫箱中培養之以爲對照。

4.*Trichoderma sp.* 之 Toxin 對腦菌病菌及洋菇生長之影響試驗：

Trichoderma sp. 培養於 24°C 5ℓ 之液體中即

Glucose	20g
Soluble starch	20g
NH_4Cl	5g

KH_2Po_4 5g
$MgSo_4$ 25g
KCl 1g
$FeSo_4$ trace in 1000c.c. water

培養一星期後，於 60°C 之下減壓蒸溜剩餘之乳白色液狀物，以洋菜稀釋法接種腦菌病病原菌及洋菇（547品系），觀察其生長情形，共分爲五種處理 Toxin 之量分爲 1％、2％、3％、4％及 5％培養基爲馬鈴薯葡萄糖洋菜培養基。

5.洋菇菌絲對 *Trichoderma sp.* 之抗性檢定：

供試洋菇品系：547，541，542，543等四品系。

a. 濾紙處理法：

馬鈴薯及葡萄糖之液體培養中接種 *Trichoderma sp.* 培養數日後至表面長滿菌絲，生長期間攪拌2～3次，以殺菌後之小圓形濾紙浸入過濾之 *Trichoderma sp.* 培養液數秒鐘，取出移入已生長至相當程度之洋菇菌絲 P.D.A 培養基四角瓶內之四周培養於 24°C ，一星期後觀察洋菇菌絲之生長勢，另無處理者爲 CK。

b. 洋菜稀釋法：

Trichoderma sp. 培養於馬鈴薯及葡萄糖液體培養基中72小時後之過濾汁液，以不同量 10％，20％及30％加於馬鈴薯葡萄糖及洋菜培養基後接種洋菇547品系，培養於 24°C定溫箱中，二星期後觀察洋菇菌絲生長狀況。

三、試驗結果

1.腦菌病病原菌對氨態氮之生理利用試驗結果如下表。

表一：腦菌病病原菌之氮素營養試驗表

Table 1. Nitrogen Nutrition of *Diehliomyces microsporus* Experiment.

Treatment / First and second / Repeat	1		2		3	
	(1st)	(2nd)	(1st)	(2nd)	(1st)	(2nd)
I. A. Basal Medium	−	−	−	−	−	−
B. Basal Medium+Biotin	−	−	−	−	−	−
C. Basal Medium+Thiamine	−	−	−	−	−	−
D. Basal Medium+Biotin+Thiamine	−	−	−	−	*	−
II. A. Basal Medium+$NaNO_3$	−	−	−	−	−	−
B. Basal Medium+Biotin+$NaNO_3$	−	+	−	+	−	+
C. Basal Medium+Thiamine+$NaNO_3$	+	+	+	+	−	+
D. Basal Medium+Biotin+Thiamine+$NaNO_3$	−	+	−	+	*	+
III. A. Basal Medium+$(NH_4)_2SO_4$	−	−	−	−	−	−
B. Basal Medium+Biotin+$(NH_4)_2SO_4$	−	−	−	−	−	−
C. Basal Medium +Thiamine+$(NH_4)_2NO_4$	−	−	−	−	−	−
D. Basal Medium+Biotin+Thiamine+$(NH_4)_2SO_4$	−	−	−	−	−	−
IV. A. Basal Medium+Glucose	+	+	+	+	*	−

B. Basal Medium+Biotin +Glucose	+	+	++	+	++	+
C. Basal Medium+Thiamine+Glucose	+	+	++	+	+	+
D. Basal Medium+Biotin+Thiamine+Glucose	+	+	+	+	+	+
V. A. Basal Medium+ +$NaNO_3$+Glucose	–	–	–	–	–	–
B. Basal Medium+Biotin+$NaNO_3$+Glucose	–	–	–	–	–	–
C. Basal Medium+Thiamine+$NaNO_3$+Glucose	–	–	–	–	–	–
D. Basal Medium+Biotin+Thiamine+$NaNO_3$+ Glucose	–	–	–	–	–	–
VI. A. Basal Medium+$(NH_4)_2SO_4$+Glucose	–	–	–	–	–	–
B. Basal Medium+Biotin+$(NH_4)_2SO_4$+Glucose	–	–	–	–	–	–
C. Basal Medium+Thiamine+$(NH_4)_2SO_4$+Glucose	–	–	–	–	–	–
D. Basal Medium+Biotin+Thiamine+$(NH_4)_2SO_4$+ Glucsoe	–	–	–	*	–	–

P.S. ＋號表示生長量　　　　　　　　1st:57.1.7.

－號表示不生長　　　　　　　　2nd:57.3.15.

* 號表示有雜菌生長

第二次試驗結果證實第一次試驗之不明確部份，而知腦菌病病原菌可利用硝酸態氮供其生長之用，對氨態氮則不能利用。

2.腦菌病病原菌對鹽類滲透壓之抗性試驗結果如下：

表二：腦菌病在鹽類溶液中抗性試驗結果

Table 2. The results of osmosis of several solution to *Diehliomyces microsporus* experiment.

Conc. normal (N) \ Repeat \ Salt \ Time		1/2hr.		1½hr.		3hr.		6hr.	
		$(NH_4)_2SO_4$	NaCl	$(NH_4)_2SO_4$	NaCl	$(NH_4)_2SO_4$	NaCl	$(NH_4)_2SO_4$	NaCl
1 (N)	I	A	A	A	++	++	++	++	++
	II	A	a	A	++	++	++	+	++
	III	A	++	A	++	++	+	–	+
2 (N)	I	A	a	A	++	++	++	+	+
	II	A	++	A	++	++	++	+	+
	III	A	++	A	++	++	+	+	+
4 (N)	I	a	++	A	–	+	–	+	–
	II	a	+	++	–	+	–	+	–
	III	+	+	++	–	+	–	–	–

8 (N)	I	a	+	a	−	−	−	−	−
	II	卄	+	卄	−	−	−	−	−
	III	卄	+	卄	−	−	−	−	−
10 (N)	I	−	−	−	−	−	−	−	−
	II	−	−	−	−	−	−	−	−
	III	−	−	−	−	−	−	−	−

P.S. A:Ascocarp 多
a :Ascocarp 少
卄:Mycelium 多
+:Mycelium 少
−:死 亡

由上表可知 10N 之食鹽與硫氨可使腦菌病之子囊果因滲透壓作用而溶解，食鹽 4N 以上處理 1 小時半及硫氨 8N 以上處理 3 小時可使子囊果死亡，腦菌病病原菌之菌絲生長依處理時間之長短與 N 數而遞減。

3. 洋菇病原菌之致死溫度與時間試驗結果如下表。

表三：洋菇病原菌之致死溫度與時間試驗結果（乾熱處理者）

Table 3. The results of thermal death times for some pathogens of cultivated mushruom (*Agaricus bisporus*) Experiment (Treatment in incubator)

Pathogen	Repeat \ Time (hours)	1	2	4	8	24	CK
Diehliomyces microsporus	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Trichoderma koningi	1		−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Thielavia terricola	1	+	+	+	+	−	+
	2	+	+	+	+	−	+
	3	+	+	+	+	−	+
Fusarium sp.	1	+	+	−	−	−	+
	2	+	+	−	−	−	+
	3	+	+	−	−	−	+
Penicillium spp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+

Chaetomium sp.	1	–	–	–	–	–	+
	2	–	–	–	–	–	+
	3	–	–	–	–	–	+
Cephaliophora sp.	1	–	–	–	–	–	+
	2	–	–	–	–	–	+
	3	–	–	–	–	–	+
Myriococcum sp.	1	+	–	–	–	–	+
	2	+	–	–	–	–	+
	3	+	–	–	–	–	+
Helminthospora sp.	1	–	–	–	–	–	+
	2	–	–	–	–	–	+
	3	–	–	–	–	–	+
Sphaerotheca sp.	1	+	–	–	–	–	+
	2	+	–	–	–	–	+
	3	+	–	–	–	–	+
Mucor sp.	1	+	+	+	–	–	+
	2	+	+	+	–	–	+
	3	+	+	+	–	–	+

表四：洋菇病原菌之致死溫度與時間試驗結果（濕熱處理者）

Table 4. The results of thermal death time for some pathogens of cultivated mushruom experiment (Treatment in water bath)

Pathogen \ Repeat \ Time (hours)		1	2	4	8	24	CK
Diehliomyces microsporus	1	–	–	–	–	–	+
	2	–	–	–	–	–	+
	3	–	–	–	–	–	+
Trichoderma koningi	1	+	+	+	–	–	+
	2	+	+	+	–	–	+
	3	+	+	+	–	–	+
Thielavia terricola	1	+	+	+	+	+	+
	2	+	+	+	+	+	+
	3	+	+	+	+	+	+

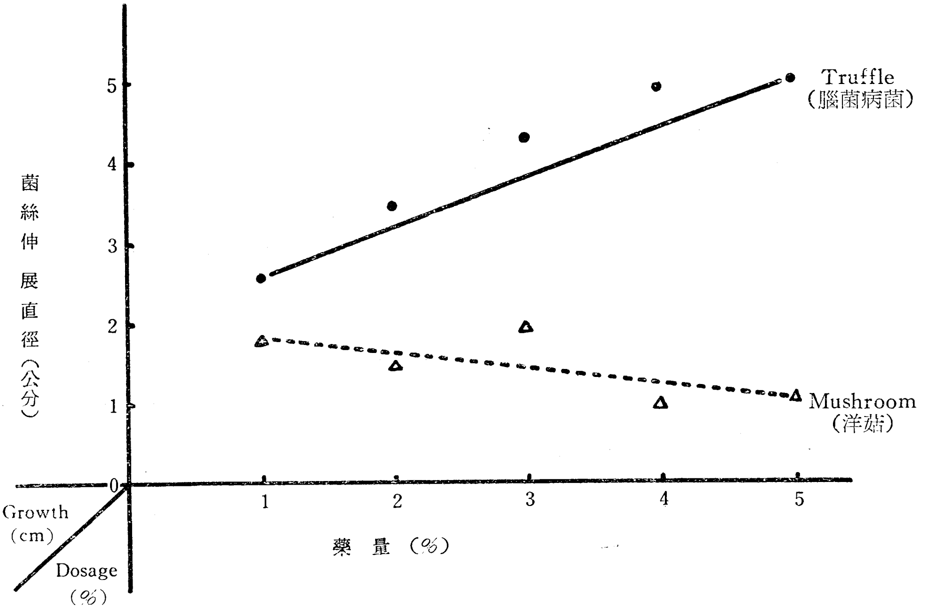
Fusarium sp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Penicllium spp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Chaetomium sp.	1	+	−	−	−	−	+
	2	+	−	−	−	−	+
	3	+	−	−	−	−	+
Cephaliophora sp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Myriococcum sp.	1	+	−	−	−	−	+
	2	+	−	−	−	−	+
	3	+	−	−	−	−	+
Heiminthospora sp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Sphaerotheca sp.	1	−	−	−	−	−	+
	2	−	−	−	−	−	+
	3	−	−	−	−	−	+
Mucor sp.	1	+	+	+	+	+	+
	2	+	+	+	+	+	+
	3	+	+	+	+	+	+

P.S. ＋表示生長

－表示死亡

乾熱處理經24小時者全部死亡，除 *Thielavia sp. Mucor sp.* 及 *Fusarium sp.* 須較長之處理時間外，濕熱處理者除 *Mucor sp.* 及 *Thielavia sp.* 無效，及 *Trichoderma sp.* 須處理8小時以上方死亡外，其餘病原菌於 60°C 處理2小時以上均達其致死程度。

4. *Trichoderma sp.* 分泌之 Toxin 對腦菌病菌及洋菇生長之影響試驗結果：



圖一：*Trichoderma* sp. 之 Toxin 對腦菌病菌及洋菇生長之影響

Figme 1. Influence of toxin of *Trichoderma* sp. on growth of cultivated mushroom and truffle disease (After inoculation one week)

Trichoderma. sp. 之 Toxin 3％以上時腦菌病病原菌有促進其生長與發育之趨勢，相同情況下對洋菇之生長有顯著之影響。

5. 洋菇菌絲對 *Trichoderma* sp. 之抗性檢定試驗結果：

表五：洋菇對 *Trichoderma* sp. 之抗性檢定

Table 5 The resistance of cultivated mushroom to *Trichoderma* sp. (With paper disc method)

Race of mushroom \ The growth of mycelium \ Repeat	1	2	3	4	Ck
547	3.8×3.9	3.7×3.6	3.8×3.7	3.6×3.6	4.2×3.8
543	3.2×2.2	2.8×2.4	2.6×2.5	3.1×2.3	3.5×3.4
542	3.3×3.4	3.0×2.9	3.1×2.8	3.0×3.0	3.8×4.0
541	2.5×2.1	2.3×2.2	2.4×2.5	2.1×1.9	3.1×2.9

表六：洋菇對 *Trichoderma* sp. 之抗性檢定

Table 6. The resistance of cultivated mushroom to *Trichoderma* sp.

Race of mushroom	Repeat \ Treatment	I 10%	II 20%	III 30%	CK
	1	3.8×3.5	1.8×1.7	1.2×0.8	5.2×4.9
547	2	3.6×3.4	1.9×1.7	1.0×1.0	6.0×5.0

	3	3.9×3.3	2.2×2.8	0.9×0.9	5.8×4.7
	4	3.2×3.6	2.0×2.1	1.1×0.7	5.3×4.2
543	1	1.8×1.7	1.6×1.2	0.8×0.4	2.7×2.5
	2	2.8×1.9	1.8×1.7	0.9×0.7	2.4×2.2
	3	2.4×1.7	1.7×1.5	0.8×0.8	2.0×2.0
	4	2.0×1.8	1.5×1.2	0.8×0.6	2.3×1.8
542	1	3.5×3.3	2.0×1.6	0.9×0.8	5.4×4.0
	2	3.0×2.8	1.5×1.1	1.0×0.9	4.8×3.7
	3	3.0×2.5	2.1×2.1	0.7×0.7	5.2×3.8
	4	3.0×2.3	1.6×2.0	1.2×1.1	3.8×3.7
541	1	2·2×1.7	1.4×1.3	0.5×0.4	3.1×2.2
	2	1.9×1.5	1.6×1.5	0.3×0.5	3.0×2.1
	3	2.5×2.8	1.8×1.2	0.5×0.5	2.3×2.3
	4	3.0×2.8	1.5×1.3	0.4×0.3	2.4×2.5

P.S. 表中數字表示洋菇菌絲之生長直徑 (cm)

洋菇四種不同品系中，以547品種對 *Trichoderma.* 之抗性最强次爲 542、543，及 541品系培養基中含 10%以上之*Trichoderma* sp. 汁液即影響洋菇菌絲生長，含30%則極爲顯著，四種品種系中仍以547品種抗性最强。

四、討　論

1. 腦菌病病原菌對氨態氮之生理利用：

第二次重覆測驗結果與第一報相同，可知腦菌病病原菌能利用硝酸態氮供其生長所需，對氨態氮則不能利用，根據徐氏(6)報告 (1967) 洋菇之氮素營養能利用氨態氮，而硝酸態氮不能供其生長，由此結果，洋菇與腦菌病病原菌之氮素營養生理爲一對比，利用此差異點，可作爲防治腦菌病之參考，如製作堆肥時，盡量使用氨態氮源，可防止腦菌病之發生。Stroll 氏(13) (1943) 曾證實堆肥中所含氮化合物之氨化作用，可阻礙腦菌病病原菌之孢子發芽，Schisler 氏(11) (1962) 亦報告洋菇能利用有機氮，如可溶性蛋白質，或氨基酸混合物，與本試驗證實硝酸態氮可利洋菇腦菌病病原菌生長之用，結果相符。

2. 根據 Scurti 氏等(12) (1965) 研究報告，腦菌病病原菌組織之切面外圍有一層薄膜，因此形成半透膜作用在鹽類與細胞之間發生滲透壓作用，因此使整個組織體發生脫水作用而致死。本試驗目的在鹽類中，尋找對洋菇無害，能使腦菌病病原菌之子囊果脫水致死之鹽類。P.B. Flegg 氏(4) (1962) 曾報告每一箱份之覆土中加 8gr 以上的食鹽，對洋菇菌絲之生長無不良影響，可見食鹽對洋菇生長影響甚少。又根據本試驗第一段，洋菇菌絲能利用氨態氮，而腦菌病病原菌幾乎不能利用氨態氮，故使用食鹽與硫氨兩種鹽類，是研究滲透壓脫水致死之理想材料，本試驗結果，對將來罹腦菌病病原菌之菇床處理上，有應用價值。

3. 洋菇腦菌病之致死溫度試驗：本段爲進行後醱酵之預備實驗，一般後醱酵在 55°C～60°C 之間進行，在溫度範圍中，本省常見之幾種病原菌能在多少單位時間內死亡，是在進行後醱酵以前急待解決

之問題，又在後醱酵進行中，利用蒸汽或乾熱處理，兩者效果良否，尚未明瞭，故本實驗分爲乾熱與濕熱兩種方法進行實驗，所得之結果如表三、表四。類似此項之問題， Lamber氏(9) (1957) 曾報告 *Chaetomium sp. Trichoderma sp.* 及 *Diehliomyces microsporus* 等病原菌，於149°F (65°C)乾熱處辦24小時即死亡。本實驗結果於 140°F (60°C) 處理24小時者，亦達致死溫度與 Lamber 氏所言相同。

類似此種實驗， Beach 氏(2) (1937) 實驗關於 *Chaetomium sp.* 以乾熱處理 140°F(60°C) 6小時致死。 *Trichoderma sp.* 115°F～120°F (46°C～49°C)處理24小時致死。Anderson 氏(1) (1956) 亦報告， *Chaetomium sp.* 於 122°F(50°C)20小時，140°F(60°C)16小時 (濕孢子) 之處理，及*Trichoderma sp.* 122°F(50°C)處理2小時，140°F(60°C) 處理½小時 (濕孢子) 亦達其致死程度，以外關於腦菌病病原菌，*Diehliomyces microsporus* Lambert(8)(1962)與Kligman (7)兩氏報告， 180°F(82°C)處理孢子5小時180°F(82°C) 處理孢子7小時亦不死亡，本實驗處理腦菌病病原菌絲於140°F(60°C)，乾熱或濕熱處理1小時以上即達致死程度。

4. *Trichoderma sp.*分泌之毒素(Toxin)對腦菌病病菌及洋菇生長之影響試驗，本段試驗之最初動機，是在作腦菌病病原菌液體培養時，發現被 *Trichoderma sp.* 汚染之處，腦菌病病原菌生長良好，但如先接種 *Trichoderma sp.* 後，再接種腦菌病病原菌，則因 *Trichoderma sp.* 生長迅速，而腦菌病病原菌生長比較緩慢之故，未能有結果，後進一步試驗：利用 *Trichederma sp.* 之培養濾液，減壓蒸溜(60°C之下) 後，所得之白色結晶物，使用洋菜稀釋法，觀察腦菌病菌及洋菇菌絲之生長情形，獲得結果如圖一，顯示 *Trichoderma sp.* 所得之物質，能促進腦菌病菌之生長，而抑制洋菇菌絲之發育 。Plattner (10)等氏 (1948) ，曾經以蕃茄萎凋病病原菌 (*Fusarium oxysporium*)之培養濾液，以同樣方法減壓蒸溜，而得到 L.C.M. (Lycomarasmin)物質。

根據橋岡氏(17) (1961) 之報告，使用 *Trichoderma sp.* 之培養濾液，對香菇亦有抑制生長之趨向，他認爲 *Trichoderma sp.* 所分泌之毒素 (Toxin) 有兩種，一爲 Viridin ($C_{20}H_{16}O_{.}$)一爲 gliotoxin ($C_{13}H_{14}N_2S_2O_4$)，由本試驗推論洋菇菌床上所分離之 *Trichoderma sp.* 也能分泌出類似此兩種物質， 抑制洋菇菌絲之生長， 另一方面却有促進洋菇腦菌病病原菌發育與生長之功能 。*Trichoderma sp.*與腦菌病菌，互相危害洋菇之生長，使洋菇之產量減少，而菇農之所以損失慘重此爲一大原因，故防治腦菌病之危害，必先防治 *Trichoderma sp.* 。

5. 關於洋菇菌絲對 *Trichoderma sp'* 之抗性檢定試驗：以本省目前推廣之四種品種，547、543、542、541，及以 *Trichoderma sp.* 爲指示生物來作抗病性之檢定，其結果在表六及表七中，可見547品種之抗 *Trichoderma sp.* 性質甚爲良好，據胡氏等(16) (1967) 報告，547品種之品質、產量、形狀等各方面，均屬優良品種之一，可知本品種爲抗病良質之優良品種。

五、摘　　要

1. 腦菌病病原菌對氨態氮之生理利用，程度甚低，但稍有能利用硝酸態氮之趨勢。
2. 鹽類如 NaCl 及 $(NH_4)_2SO_4$ 濃度 4N 以上處理腦菌病病原菌子囊果3小時以上，可因其滲透壓之作用抑制其生長。
3. 60°C 乾濕熱處理洋菇各種病原菌除 *Mucor, Thielavia sp.* 及 *Trichoderma sp.* 外，其餘處理2小時以上，即達其致死程度。
4. *Trichoderma sp.* 分泌之 Toxin 證實對洋菇腦菌病病原菌有促進生長與發育之趨勢，但在相同情況下，對洋菇則否。
5. 洋菇以547品系對 *Trichoderma sp.* 之抗性最强次爲542、543品系541最弱，培養基中含20%以上之 *Trichoderma sp.*汁液即顯著影響洋菇菌絲生長。

五、參考文獻

1. Anderson F.A. 1956 The Pennsylvania State Univ (M.S. thesis)
2. Beach, W.S. 1937 Pennsylvania Agr. Exp. Sta. Bull 351 32pp
3. Diehl, W.W. and E.B. Lambert 1930 Mycologia 22(5)223-226
4. Flegg, P.B. 1962 Mushroom Science V P.300-313
5. Helen M. Gilkey 1954. Mycologia 46(6) 788-789
6. Hsu H.T. and K.J. Hu 1967 Jour. of Taiwan Agr. Res. V16(3);25-28
6. Kligman, A.M. 1944 Phytopathology 34:376-384
8. Lambert, E.B.1932 Newsletter, Div of Mycol. & Plant Dis Survey, B.P.I.,U.S. Dept.Agr.
9. Lambert, E.B. and T.T. Ayers 1957 Plant Disease Report V:141(4) 348-353
10. Plattner, P.A., Clauson-Kaas,N,Boller, A.4N.Nager 1948 Helv Chim Acta 31:860
11. Schisler L.C. and J.W. Sinden 1962 Mushroom Science V:150
12. Scurti J.C. et G. Borzini 1965 Mushroom Science VI. P.523-528
13. Stoller B.B. 1943 Plant Physiology Vol 18 No25:46~52 No.25:1~8
14. 杜自彊、于紫靜：臺灣省農業試驗所試驗報告 (1967)
15. 胡弼仁、毛鑑銘：農業研究3 (4) :36 (1964) 。
16. 胡弼仁、宋細福：農業試驗所報告NO. 25 : 1~8 (1967)
17. 橋岡良夫：菌蕈研究報告第1號 (1961)

PHYSIOLOGICAL STUDY OF TRUFFLE DISEASE ON CULTIVATED MUSHROOM

by

T. C. Dough and Z. J. Yu

Summary

Ammonium nitrogen was failure to be utilized as sources of nitrogen by pathogen of truffle disease (*Diehliomyces microsporus*). but it was generally used to support the growth of cultivated mushroom (*Agaricus bisporus*). Only nitrate nitrogen could be used by *Diehliomyces microsporus*. That was a significant different about nitrogen nutrition between cultivated mushroom and truffle disease.

The addition of the solution of salts as NaCl and $(NH_4)_2SO_4$ at the concentration above 4N to ascocarps of *Diehliomyces microsporus*, could control the growth of the fungus. Most mushroom diseases pathogens were killed with heat(140°F) under moist and dry conditions. Exceptions are *Thielavia* sp.,*Mucor sp.* and *Trichoderma* sp.

A metabolic product as toxin of *Trichoderma* sp. had been testified that it could promote the development of the causal organism, but under the same conditions it was ineffective to growth of cultivated mushroom furthermore it decresed the yield.

In regard with the resistance of several varieties of cultivated mushroom to *Trichoderma* sp., this experiment was proved that 547 (303) variety was the best one. 542 and 543 variety came next and 541 variety came after that. If the medium contained above 20% of the filtrate *Trichoderma* sp., it had great influented on growth of hyphae of cultivated mushroom.

溴化甲烷燻蒸對洋菇病害預防之效果

杜　自　彊

一、前　言

本省洋菇栽培至今已達十年有餘，開始栽培之初期，產量尚佳，每坪能產30公斤者不在少數。但繼續栽培6～8年之後，其單位面積之產量逐漸減低。例如民國五十年之平均產量每坪尚有 19.49 公斤，到了民國五十五年已降低到 10.9公斤（3）。關於此原因之探討，由於學者之立場不同，其意見則各略異，據筆者之調查，由於什菌之汚染堆肥及環境，佔有很大的比率。（4）（6）

爲究明什菌汚染之程度對產量之影響如何之問題將選定利用溴化甲烷（Methyl bromide）燻蒸之方法，防止或解除什菌之汚染，以明瞭燻蒸處理區與無處理對照區之間，病害之發生情形與產量方面之差異如何而設計本試驗。

關於溴化甲烷對眞菌之燻蒸殺菌效果問題，曾由 Munneck 氏（1959）報告（13），溴化甲烷燻蒸對 *Alternaria solani* 之殺菌作用良好，並指出溫度與濕度之增高對燻蒸作用有促進效果。被燻蒸物之水分含量又示同一傾向。神戶氏（1957）報告（10）methyl bromide 燻蒸時之投藥量，（氣體濃度）被倉庫天花板、牆壁及被燻蒸物之本身所吸收，而一部份由於漏氣而損失，眞正作用於菌類者只有投藥量之1/5而已。接着由柳井及松野兩氏（1962～1964）報告，使用溴化甲烷燻蒸貯藏穀類之微生物前後達五報之多（1）（2）（7）（8）（9），其中指出溴化甲烷燻蒸時之溫度、濕度之增大對於燻蒸效果均有促進作用，而燻蒸時間與氣體濃度，則因對象微生物種類之不同而略有差異，並其促進範圍有一定的限度。

筆者曾於1967年（5）使用 Chloropicrin 與 Grand 乳劑爲主要成分之滅菌彈，燻蒸洋菇舍，視其燻煙殺菌後對洋菇產量之影響之結果，四個試驗區均能提高洋菇生產量。

根據以上之各報告筆者選定使用 Methyl Bromide 燻蒸菇舍及菌床堆肥，進行本試驗，茲將已得之初步結果草成本文，本初報中未盡之部份尚多，筆者擬繼續研究以求燻蒸消毒法之實用化。

本試驗之進行蒙洋菇研究基金 57/57-MRF-PP-22 號計劃之資助，蔗作改良場李嘉郁先生提供場地，日本大洋興業公司提供塑膠布，僅此申謝，並仰各界先進多加批評指導。

二、材料及方法

設栽培坪25坪容積約 256立方公尺之一般稻草菇舍2間，按照一般方法製成之洋菇栽培用堆肥移入並造床。在舍內之通路處放置覆蓋用之土壤（pH 調整完畢）用竹籠裝田，以便同時消毒。如此準備完畢之菇舍中任選一間用塑膠布把整個菇舍罩蓋（P.E. 布 13m×13m 日本大洋興業公司出品）由塑膠布之外側通入溴化甲烷開罐器之橡皮管繼續送入溴化甲烷8磅半（每立方公尺2000）量，然後密閉狀態維持24小時。如此經過堆肥、覆土、菇舍、同時燻蒸，希望能達到殺菌消毒之效果，另一間則不經過任何處理，只按照一般情形入床，此外之栽培管理均依照政府推廣之標準方法，並按時記載兩處理區之洋菇產量、什菌消長、病害發生情形、並附帶檢查菇體內之菇蠅數量。

註：採收期間自民國五十六年十二月十三日起至五十七年四月十日止。使用藥品爲Dow chemical co. 出品內含 Methyl bromide95% Chloropicrin5%。

試驗地點爲臺南縣柳營鄉人和里。

塑膠布使用特製 P.V.C.（Fumigation Film Tent）

三、結果及討論

按上述之方法試驗結果，在取開覆蓋塑膠布後數小時立即下種，並注意觀察菌絲生長及什菌發生情形。其概況如下：

1. 下種後四天在 Methyl Bromide 處理區發現白色菌絲聚落多處範圍甚小，直徑約 10～15cm 經檢查結果獲知爲褐皮病之菌絲。無處理區發現 *Fusarium* 三處 *Trichoderma* 數處 *mucor* 及 *Rizopus* 各一處，直徑約在 5～10cm 之間。
2. 下種後七天，處理區之褐皮病菌範圍擴大，但洋菇菌絲伸展之速度非常迅速，兩者均生長良好，無處理區之什菌種類並無增加範圍也甚少擴展，但洋菇菌絲伸展之速度不如處理區。
3. 下種後九天覆土，此後因氣溫下降，床土上之什菌兩區均甚爲稀少。
4. 處理區在十二月七日開始發菇，無處理區則在十二月十三日開始發菇，但因其量不多，故在試驗統計上以十二月十三日開始，記錄其每週之洋菇產量比較如下表。並以常用於高級試驗之 (12)student 氏對比法 (11) 分析其差異顯著性。

表一：溴化甲烷燻蒸處理對洋菇產量之差異比較表

處理區產量 (kg)	對照區產量 (kg)	差異 (D)	D^2
21.3	15.3	6.0	36.00
65.6	38.2	27.4	750.76
100.6	104.8	− 4.2	17.64
59.6	61.5	− 1.9	3.61
87.2	76.2	11.0	121.00
61.7	52.8	8.9	79.21
57.4	39.6	17.8	316.84
54.2	56.1	− 1.9	3.61
32.5	30.6	1.9	3.61
29.0	25.0	4.0	16.00
30.9	19.1	11.8	139.24
21.3	16.0	5.3	28.09
30.9	23.1	7.8	60.84
35.1	19.6	15.5	240.25
26.6	16.3	10.3	106.09
20.2	8.4	11.8	139.24
67.4	25.7	41.7	1,738.89
39.8	19.1	20.7	428.49
		193.9	4,229.41

$M = 193.90 \div 18 = 10.772$

$D^2 = 4{,}229.41 \div 18 = 234.967$

平均差異 $M = \frac{193.90}{18} = 10.772$

差異自乘之和 $= 4,229.41$

差異自乘之平均 $= \frac{4,229.41}{18} = 234.967$

標準差 $S.D. = \sqrt{D^2 - M^2} = \sqrt{234.967 - (10.772)^2} = 10.907$

$Z = \frac{M}{S.D} = \frac{10.772}{10.907} = 0.987$

$n = 18$

偶差爲1666：1

處理區與無處理區比較，差異顯著。

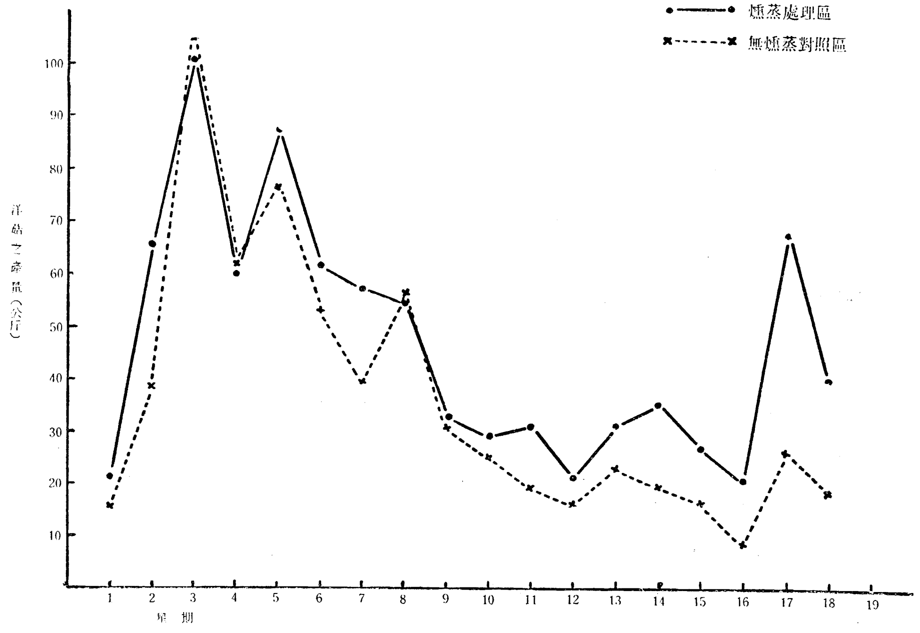
由上表可知溴化甲烷處理區雖然發生褐皮病，但均因爲空氣傳染所致，因而對產量影響不大，燻蒸處理與無處理之間差異極顯著，並示methyl bromide 爲洋菇病害預防上有希望之燻蒸劑。

再以經營上之立場分析，若以 methyl bromide 燻蒸所用之費用以每磅市價80元，計九磅總共藥品費720元再加之塑膠布之固定資產計以 1,000元計算，處理區之產量減無處理區之產量，（840.7-647.4=193.3）即可得193.3公斤，以每公斤14元計算，則合乎2,406元2角，再扣除施藥成本之 1,000元尚有1,406元之利益，並且下年度再施藥時，可不必再購置塑膠布。

本試驗僅係密閉菇舍之預備試驗，故在燻蒸後取開塑膠布時容易引起空氣傳染病菌，今後若欲燻蒸可採用省農會何銘樞先生設計之密閉菇舍。

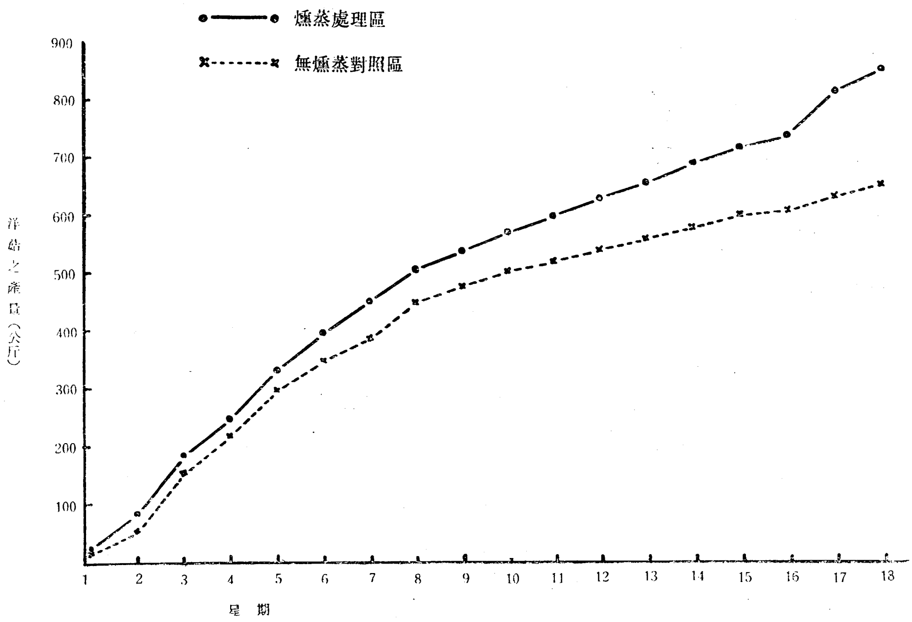
玆將上表所記錄之每週產量，換算成累積產量繪成產量曲線二種以示明瞭。

圖一　洋菇產量比較圖（每星期產量）



5. 處理區與對照區於栽培期間各取樣 5 次送加工廠檢查菇蠅數，檢查結果如下表：

圖二　洋菇累積產量比較圖



表二：燻蒸處理區與對照區菇蠅數之比較表（每100g/菇蠅數）

次　　數	燻　蒸　處　理　區	對　照　區
1	0	15
2	1	27
3	1	19
4	0	21
5	0	16

由上表可知 methyl bromide 之燻蒸處理，對害蟲防治上仍有良好之效果。

本試驗擬在 57/58年期繼續進行。

四、摘　要

本試驗爲明瞭溴化甲烷燻蒸在洋菇栽培上之利用價值；尤其對病蟲害預防效果之研究而舉行之預備試驗。茲將已得之初步結果摘要如下：

1. 洋菇栽培舍，用燻蒸用之塑膠布罩蓋，可以施行燻蒸處理。
2. 以每立方公尺 20cc ，24小時之溴化甲烷燻蒸可得病蟲之預防效果。
3. 燻蒸處理區褐皮病之汚染較多，但所幸對產量之影響甚微。
4. 燻蒸處理區之產量超過無處理對照區之產量，與差異顯著。
5. 溴化甲烷燻蒸，在經營上仍有經濟價值。
6. 本燻蒸處理對菇蠅防治上仍有良好之效果。

五、參考文獻

1. 上村光男、松浦愼治、松野守男、柳井昭二（1962）食糧研究所報告，15：94～97。
2. ——— （1963）同上17：49～54。
3. 吳國璋等（1956）洋菇栽培，中國農復會，臺灣省政府農林廳。
4. 杜自彊（1967）臺灣省農業試驗所報告 No.25：63～74。
5. 杜自彊、黃添福（1967）農業研究16（4）：32～40。
6. 胡賜仁、杜自彊（1964）農業研究13（4）：34～47。
7. 松野守男、柳井昭二（1963）日植病報告28（4）:216～220。
8. 柳井昭二、松野守男（1963）日植病報告28（5）:258～261。
9. 柳井昭二、松野守男、松浦愼治（1964）日植病報告29(1)43—47
10. 神戶隆造（1957）麥研叢書第19輯，東京。
11. Love H.H. (1923) Jour of Am. Soc. of Agr. 15:217～224
12. Love H.H. (1924) Jour of Am. Soc. of Agr. 16:68～73
13. Manneck D. C. (1959) Canad, J. Bot, 37:51～58

THE CONTROL EFFECT OF METHYL BROMIDE FUMIGATION ON PESTS OF MUSHROOM CULTIVATION

By

T. C. Dough

SUMMARY

In order to clarify the utilized value of methyl bromide fumigation on cultivation of mushroom, this experiment was made. Especially, study on the preparatory test of control effect for some pests of cultivated mushroom.

The preliminary results were summarizied as follows:

1. Fumigation treatment could be taken on mushroom house covered with polyvenyl Chloride films tent.
2. Methyl bromide could control the pests of cultivated mushroom in dosage of $20cc/m^3$ for 24 hrs.
3. In the treated area brown plaster mold disease was more occured than in other areas. Fortunately, it affected the mushroom production slightly.
4. It has significant difference between the area treated with fumigation and the untreated area on mushroom production.
5. Fumigation of methyl bromide has the economic value in application.
6. This fumigation treatment still has the good effect for control the cecid fly.

文 獻 介 紹

ABSTRACTS OF LITERATURE

一、稻品種間放射線感受性之差異研究 II 以幼苗長，鞘葉長，花粉稔實性，種子稔實性之減少和葉綠素突變率表示之放射線感受性〔鵜飼（1968）日本育種學雜誌18（3）：127～138〕。

利用11種水稻和3種陸稻為材料，分別處理19.5、30.0、40.0和50.0kr之X-線或15-60Kr之伽瑪線。然後研究幼苗長、鞘葉長、花粉及種子稔實性及葉綠素突變率等。其結果發現所有之品種具有相同之線量反應型。即線量愈多，減少之程度愈大。感受性與根長及幼苗長之減短間，整個生育期均有很高之相關。而鞘葉長與某品種其後期具有較高之根長縮短者有相關。

20和 30Kr 以上之處理。其花粉稔實率各品種之差異均不顯著。除 20Kr 外，其餘10到40Kr 處理之谷粒結實率與線量反應曲線，所有品種均相似。花粉與谷粒稔實率之減少以及葉綠素突變率與根長之減少間無相關關係。

由此資料之結果建議，控制品種間根長減少差異之因子可左右幼苗生育和鞘葉伸長。但對花粉與谷粒不稔性和葉綠素突變則無影響。（嚴盛添）

二、稻抗縞葉枯病品種之育種研究 II 外國品種抗病性之遺傳研究〔鷲尾、鳥山、江塚和櫻井（1968）日本育種學雜誌18（3）：167～172〕。

五種引進之抗病品種，Zenith, Surjumkhi, Charnack, Russia No.5 和 Ketan-Nangka 與感病品種 Kihiyoshi雜交。由其雜交後代研究所得之結果如下。

F_1 和 Br 之抗病性與抗病品種 Zenith 相似，故表示抗病因子是完全顯性。同時 Zenith 親本具有兩對補助因子。而 Surjumkhi 具有一對不完全顯性因子，同時獲知感病羣內病症之嚴重性受母本細胞質之影響，但其分離比則差異不大。在其餘三組合中，親本之抗病性，有某種程度之差異。但其實際之分佈則與 Surjumkhi X Kihiyoshi組合相似。故 Charnack, Russia No. 5 和 Ketan-Nangka三親本是受一對不完全顯性因子所支配。所有之資料均證實，所假定之理論是正確的。（嚴盛添）。

三、水稻品種混合族羣生育性狀競爭力之季節性變化〔秋濱（1968）日本育種學雜誌 18（3）：123～125〕。

利用北陸52號和 Yamakogane 兩差異特別明顯之水稻品種為材料。由以前之試驗中已知Yamakogane較北陸52號具有較高之桿長和谷粒產量，但競爭力較低。

本試驗直接播種（50×50cm），調查每株之分蘗數、綠葉數、葉面積和總乾重。其結果顯示，北陸52號之分蘗數、綠葉數、葉面積和總乾重等混合族羣之生育情形較單獨品種區强。Yamakogane 則相反。同時，北陸 52 號整個生育期中，其競爭力均較 Yamakogane强。

由競爭力與分蘗數之變方分析結果表示，品種間差異達1％水準。而其他如季節，品種與季節之交感則不顯著。表示北陸52號，一直都有較强之競爭力。品種間之競爭影響始於播種後50天。而三種性狀如分蘗數、綠葉數和葉面積，於抽穗前40天左右，有極明顯之競爭力差異。而總乾重之競爭力差異則一直延續到收穫期。因此可說，北陸52號之所有性狀均優於 Yamakogane。

單純與混合植株總乾重之季節變化，北陸52號在混合植株中較强，而單純植株時則Yamakogane 較强。（嚴盛添）

四、鈣對花粉發芽的影響〔Kwack.B.H.（1965）

Proc. Amer. Soc. For. Hort. Sci.86: 818-823〕

自觀賞植物及其他園藝作物上選取花粉，用於測定鈣及酸度（pH 值）對花粉發芽及花粉管生長的關係。且於培養花粉以含10%的蔗糖爲基本培養基並 100ppm 硼酸， 300ppm 硝酸鈣，200ppm硫酸鎂或 100ppm 硝酸鉀，如於缺鈣的處理亦必同時缺鉀，以免某些相同的作用產生，且以 ethylenediamine tetracetic acid. 代替鈣的供給，並以 IN 的鹽酸及 IN 的氫氧化鉀液調整其酸度 。 在花粉置入培養基前先經 24°C x 小時的情況下催芽 ， 播於培養基中的花粉 ， 每一處理約有 500 粒，由於植物亦具有競生的現象，故稍多量的花粉反有互相促進發芽並生長的效能。

適量的花粉在人爲培養基中，其發芽情形很明顯地受到培養基內所含鈣的影響，經數個重覆試驗得知 300ppm的硝酸鈣對花粉發芽及花粉管生長最有效，其濃度較高或較低對花粉作用反差，雖許多作物本身含有鈣，或某些花粉亦含有鈣，但此種鈣屬不溶性，無促進花粉發芽的效果，稱爲不溶性鈣或無效性鈣 ， 如含羞草及 Ornithogalum virens 之花粉置於無可溶性鈣的培養中並不發芽，探討鈣對花粉發芽有促進的原因，可能係因鈣附着於花粉壁上，增強了胞壁的硬度及穩定度，且可避免花粉管伸長時破裂致死。經用放射性鈣（Ca45）試驗，發現鈣可存在花粉管壁的木質區（Pectin region）中。經過46種園藝植物的試驗，知含鈣的培養液中培養花粉其促進發芽及生長情況均較無鈣者好得多。

由於鈣之吸收和培養基之酸度有密切的關係，其他陽離子亦有同樣的現象，因此酸度對花粉發芽及花粉管生長影響至巨，經過25種園藝作物試驗的結果知較高的 pH 值對花粉生長有促進的功能。

以三種不同酸度來測定其和花粉發芽並含鈣對花粉發芽的關係，由測定的結果得知 pH值的高低對鈣的吸收量相關，而且直接影響花粉發芽，細胞壁的穩定度，花粉管頂生長點的生長。經以pH5.3,7.3,8.3 的試驗，知 Raphanus rathanistrum 及 Brassica Juncea 在含有鈣的處理中，pH5.3 的處理其花粉不發芽，而 pH8.3 者其發芽率超過80%，並知鈣量和適當範圍的酸度對花粉發芽率成正比，如在培養基內含有蔗糖及硼對花粉發芽亦有促進的效能，前者可增進培養基的滲透力，並參醣類的合成，且供發芽所須的熱能，而硼亦可能增加細胞壁的强度。

酸度低花粉較易破裂，而稍高者則可促進花粉發芽，增進鈣的有效性，在過高的 pH 值對花粉發芽有妨礙的現象，超過 5000ppm 的氯化鈣對花粉發芽亦有抑制的作用。（郭義川）

五、盆栽試驗時土壤之塡充法與容水量〔Y. Ogura, H. Kume, (1967) J.Sci. of Soil and manure, Japan 38 (8):275-279〕

爲探究盆栽試驗開始時盆中土壤之水分平準値能接近目標値之塡充方法，經實驗結果所得方法如次。先把試驗用土壤經 2mm 篩別在 105～108°C 乾燥 8 小時以上，風乾後測定含水量而求得每盆所能容納之乾土重量。使用之瓷盆係直徑18cm高 19.4cm相當於1/5000公畝。由預備實驗測定塡土之體積後，從 3 公分高度把盆落下20次塡土後耙平表面測定塡充之體積，由土壤眞比重計算空隙量，加水使之成爲空隙量20%之含水量均勻混合後再塡充，40%水分土壤之製作時液肥之半量與20%水分含量所不足之水混合後與前法同樣塡充，然後液肥之另半量與20%相當之水分量混合注加於土壤中。60%、80%盆仍塡充時先以20%含水量裝土壤後再注入不足之水分量。併且肥料濃度應常保持一定濃度注入於土壤爲宜。（吳啓東）

六、原子吸光分光分析法〔北岸確三（1966）日本土壤肥料雜誌37（1）：119～125〕

原子吸光分光分析 （Atomic-absorption spectrophotometry）爲澳洲的 Walsh 氏所創始者。在1955年 Walsh 氏曾發表過論文指出該法的特點在乎不易受共存元素的干擾。至今該法已在冶金，生化學，臨床化學，農學，及化學工業等領域被廣汎的應用。

原子吸光分光分析法的原理簡單說明如下。

某種元素在火炎裡變成原子狀態之後如照射該元素的共鳴線則安定狀態（ground state）的原子可吸收該光線。現以 Zn 爲例。現將含有 Zn 的試料溶液經噴霧器成爲霧狀之後導入約 2000°K 的火炎裡。水分被蒸發，因高溫 Zn 即解離成原子狀態。現將2139A° 的光線即 Zn 的共鳴線火炎，該光線的一部分即可被吸收。此吸收量與存在於火炎中的 Zn 原子數有量的關係。因此可推算試料中 Zn 的含量。

此種分析其優點爲（1）裝置簡單，操作及保守容易。（2）靈敏度及精度高且迅速。（3）可應用於多種金屬元素。（4）不易受共存元素的干擾。（5）價格常比其他物理方法便宜。（李蘭帝）

七、培養液養分對硼素吸收的影響〔H. Tanaka (1967) Soil Science & Plant Nutrition 13(2)41-44〕

Warington 在 1923 年發現硼素爲高等植物生長的必需元素後，一般硼素的植物營養研究結果，認爲植物體硼素的缺乏與土壤中多量活動性鈣或高濃度的其他養分有關。

本試驗以蘿蔔培養于不同濃度的磷、鉀和鈣的培養液，測定硼素的吸收情況，並以向日葵培養于不同鈣濃度的培養液，以測定硼素的輸送情況。

培養液鈣濃度由 50ppm 增加至 500ppm，則蘿蔔植物體乾物量中，鈣含量由0.62%增加至3.47%，硼素含量則由32.8ppm減至 27.4ppm由此可見鈣濃度增高則植物體鈣含量亦增高，但硼素含量則反而減少。

培養液磷濃度由1ppm增加至 50ppm 則蘿蔔植物體磷含量由 0.23%增加至 1.50% ，硼含量由13.2 ppm增加至25.5ppm，鈣含量則由1.93%降至 0.73%， 磷濃度增加，植物體磷含量也增加，而且硼素的吸收量也增加，但鈣的吸收量則反而減少。

培養液鉀濃度由50ppm增加至 400ppm則蘿蔔植物體鉀含量由4.04%增加至6.36%，硼素含量由25.0ppm 降至 14.2ppm，鈣含量由2.41%降至1.40%，鉀濃度超過植物需要量時，即引起硼素的缺乏症，由此可見鉀的濃度對植物體硼素的聚集有很大的影響。

培養液鈣濃度增加，向日葵植物體莖葉鈣含量隨著增加，尤以莖部爲顯著，莖部硼素含量也隨之增加，但葉部的硼素含量則反而減低，由此結果顯示，培養液鈣濃度可影響植物體硼素的吸收與輸送，從另一觀點討論，當培養液中鈣濃度增加，則 Ca/B 比值隨着增加，由 Ca/B 比值的變化可測知硼素的缺乏狀態。（林森帆）

Vol. 17, No. 4 December, 1968

JOURNAL OF TAIWAN AGRICULTURAL RESEARCH

CONTENTS

Response of Rice Variety to Plant Spacing and Nitrogen Fertilization······W. L. Chang······1

A Screening Test for Rice Varieties Resistant to Yellow Dwarf Disease······S.M. Chiu, M.H. Lin, C.S. Huang······19

Studies on the Cultivation of Ratooned Rice

111. Effect of plowing Depth and Amount of Fertilizer on the Reviability and Yield of Ratooned Rice······C. F. Hsieh, S. Kao and C. Chiang······24

Effect of Knoxweed on the Control of Weeds in Paddy Rice······W.L. Chang······34

Crude Protein Contents of Rice Kernel of Various Mutants Induced by Irradiation······P. C. Lou, C. S. Huang······41

Influence of Mulching Materials and Fertilizer Levels on the Oil of Lemon Grass······Y. Y. Yang······47

Histogenic Demarcation in Diseased plant······C. C. Tu······51

Study on Bacterial Blight of Soybean Caused by *Pseudomonas Glycinea* Coerper······C. L. Chu, C.C. Chen.······57

Physiological Study of Truffle Disease on Cultivated Mushroom······T.C. Dough, Z.J. Yu······65

The Control Effect of Methyl Bromide Fumigation on Pests of Mushroom Cultivation······T. C. Dough······75

Abstracts of Literature······80

Published by

THE TAIWAN AGRICULTURAL RESEARCH INSTITUTE

TAIPEI, TAIWAN, CHINA

內政部出版事業登記證內版臺誌字第一一二四號
中華郵政臺字第二〇七六號執照登記為第一類新聞紙類